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# A Comparison of Four Wetlands Assessment Procedures Relevant to the Alluvial Valleys of East Texas

Amy Camp
*Stephen F Austin State University*, amycamptx@gmail.com

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# A COMPARISON OF FOUR WETLANDS ASSESSMENT PROCEDURES RELEVANT TO THE ALLUVIAL VALLEYS OF EAST TEXAS

By

AMY MICHELLE CAMP, Bachelor of Science in Environmental Science

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APPROVED:

Hans Williams,Thesis Director

Jared Barnes, Committee Member

Kenneth Farrish, Committee Member

Yanli Zhang, Committee Member

Pauline Sampson, Ph. D.
Dean of Research and Graduate Studies

ABSTRACT

Currently several methods are used by public and private entities to assess wetland functional condition in support of the Section 404 Clean Water Act program. Four of these are: *Forested Wetlands in Alluvial Valleys of the Coastal Plain of the Southeastern United States* (SEHGM); *A Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (ETXHGM); *Texas Rapid Assessment Method* (TXRAM); and the *Wildlife Habitat Appraisal Procedure* (WHAP). Little previous research compares wetland functional assessment methods. Results of the SEHGM, ETXHGM, TXRAM, and WHAP methods were compared on five East Texas alluvial valley sites within the Pineywoods ecoregion, or bottomland hardwoods.

Statistical analysis determined that the assessments did not result in similar scores. Statistical groupings placed ETXHGM and SEHGM in the same group, followed by TXRAM and WHAP individually. ETXHGM, SEHGM, and TXRAM all resulted in very high mean scores. WHAP was significantly lower overall. Since ETXHGM, SEHGM, and TXRAM resulted in such similar scores, it could be more time efficient to choose the method with the best time efficiency and largest geographic domain, such as the SEHGM.

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

# INTRODUCTION

Wetlands are unique landscape features that can be observed in numerous sizes and varieties. They offer habitat, food, and shelter to organisms, as well as provide flood control and pollution mitigation for water supplies.

Wetlands are an increasingly popular area of study, as observed in the figure below. Scientific publications containing the word “wetland” or “wetlands” in the title have grown exponentially over the last 50 years, and will likely remain important in the future (Zhang et al. 2010).

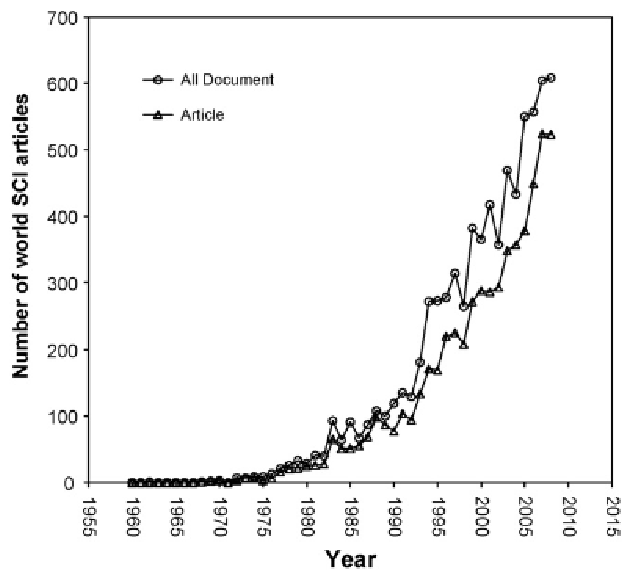


Figure 1. Number of Scientific publications referring to “wetland” and “wetlands” in the title during the last 50 years (Zhang et al. 2010)

Unfortunately, many wetlands have been drained, filled, or modified in some capacity since the colonization of America. It was not until the twentieth century that wetlands began to be recognized as a beneficial part of the environment. After so much loss and destruction, policies were put in place to protect and preserve remaining wetlands.

Federal agencies have developed different wetland definitions, although they all recognize vegetation, hydrology, and soils as indicators of a wetland. The Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) use the regulatory definition that requires the presence of the three parameters: (1) wetland hydrology, (2) hydrophytic vegetation, and (3) hydric soils. The U.S. Fish & Wildlife Service (USFWS) has a non-regulatory definition, and only requires the presence of one of the three parameters. The Natural Resource Conservation Service (NRCS) has a definition similar to the EPA & USACE, but relies more heavily on the presence of hydric soils.

Wetland identification and delineation techniques developed from the need to meet requirements for Section 404 of the Clean Water Act, which regulates the discharge of dredge and fill material into waters of the United States (WOTUS), including wetlands. Wetland identification is dependent on the presence of the three parameters as stated above: wetland hydrology, hydrophytic vegetation, and hydric soils.

Wetland functional condition assessments can also be a part of 404 permit requirements to evaluate impact assessments and guide mitigation requirements. Multiple methods for assessing functional condition have been proposed by both state and federal agencies alike. The EPA and the USACE sought to develop rapid and accurate functional assessment methods to support Section 404 of the Clean Water Act. They are currently using assessments such as the various Rapid Assessment Methods (RAM) and the Hydrogeomorphic Approach (HGM). State agencies, such as Texas Parks & Wildlife (TPW), have developed other assessment methods, like the Wildlife Habitat Appraisal Procedures (WHAP). WHAP, however, differs in that it evaluates a wetland or other habitat type based on its value to wildlife.

These methods use different metrics, but it is important to know whether or not these methods yield similar results.

If all assessment techniques lead to similar results, it may suggest wetland functional assessment could be more standardized in execution and efficiency. If a less time intensive or less hands-on approach, such as WHAP or TXRAM, is found to yield similar results to HGM, which requires more on-site data collection, it may lead to conclusions that less time and money is required to assess functionality or project impacts. However, if all or some methods yield significantly different results, it may help professionals decide which methods require the least time and yield the best results for their objectives.

A comparison of techniques will show where they overlap and differ in field metrics and evaluation. By comparing techniques rather than sites, the metrics driving the changes in scores between methods will be made more apparent. This will allow practitioners to choose the most appropriate tool for their needs, depending on the project type and location.

## OBJECTIVES

The purpose of this study is to determine if different wetland assessment tools for the forested alluvial valleys of East Texas lead to the same conclusions on functional condition. For this study the methods being compared are:

(1) *A Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Williams et al. 2010)

(2) *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in Alluvial Valleys of the Southeastern Coastal Plain of the United States* (Wilder et al. 2013)

(3) *The Texas Rapid Assessment Method* (U.S. Army Corps of Engineers 2015)

(4) the *Wildlife Habitat Appraisal Procedures* (TPWD 1995)

These methods are further referred to as ETXHGM, SEHGM, TXRAM, and WHAP, respectively.

Hypothesis:

$H_o$: All four assessment methods will result in similar functional capacity scores

$H_{a:}$ All four assessment methods will not result in similar functional capacity score

# LITERATURE REVIEW

## Wetland Background Information

What exactly defines a wetland has often been debated (Robertson 2000). As stated by Cowardin, "there is no single, correct, indisputable, ecologically sound definition for wetlands, primarily because of the diversity of wetlands and because the demarcation between dry and wet environments lies along a continuum" (Cowardin et al.1979). They vary in appearance, location, vegetation composition, and other factors. One reason for the variation in definitions and names for wetland areas is simply due to regional and colloquial preferences. Additionally, the multitude of terms for wetlands stems from their diversity, need for inventory, and the regulation of their uses (Tiner 1996).

Wetlands are unique because they are an "ecotone", or transitional zone, between the aquatic and terrestrial environments (Mitsch and Gosselink 2015). They are often complex in nature and have dynamic features. Due to the variation among scientific and legal definitions of wetlands, their global extent is difficult to determine; however, the use of multiple studies estimates they cover 5-8% of earth's land surface (Mitsch and Gosselink 2015).

Most of the area of wetlands have been lost in the past several centuries. It is estimated that the lower 48 states contained 220 million acres of wetlands in the 1600s, compared to only 103.3 million acres in the mid 1980s (Yuhas 1996). These losses are the result of urbanization (Lee et al. 2006), agricultural practices (Ardon et al. 2010), and climate change (Pitchford et al. 2012). However, the Status and Trends reports published by the U.S. Fish & Wildlife Service have shown an increase in wetland area in recent years (Dahl 1990, 2000, 2006).

Wetlands generally occur in a topographic setting that allows them to collect surface water and/or groundwater discharge (Tiner 1996). This is one of the many ways in which they can differ, as they may be found on the landscape as depressions, flat depositional areas prone to flooding, flat areas that lack drainage outlets, sloping terrain associated with springs/seeps/bogs, or open water bodies (Tiner 1996). To be considered a wetland, these areas must have enough water at some point during the year to stress plants and animals not adapted to inundated or saturated soil conditions (Tiner 1996).

Methods have been developed to determine or delineate those areas that receive “enough” water. Following the USACE definition, a wetland will meet three parameters: (1) be dominated by hydrophytes, or plants that are adapted to life in saturated soil conditions, (2) exhibit indicators of wetland hydrology, and (3) have hydric soils due to saturation or inundation. To be considered a jurisdictional wetland governed under Section 404 of the Clean Water Act it must also have a nexus, or connection, to WOTUS as defined by the USACE and the EPA.

To fulfill regulatory requirements, wetland delineations and functional assessments may be used. Determining the presence and boundary of a potential jurisdictional wetland involves the use of the three parameters (as mentioned above: hydrology, vegetation, and soils) using the 1987 national delineation manual (Environmental Laboratory 1987) or a regional supplement, such as the Atlantic and Gulf Coastal Plain supplement (U.S. Army Corps of Engineers 2010). Typically the presence of hydrophytic vegetation will extend far beyond the wetland boundary, as can hydrology indicators. Hydric soil indicators are usually the most limiting and are the best indicator of the true boundary. The technical aspects of delineation for regulatory purposes are better understood than those of wetland function. While the functions wetlands perform are now well understood, the assessment of these functions is not.

Wetland function is “the normal or characteristic activities that take place in wetland ecosystems, or simply, the things that wetlands do” (Smith et al. 1995). Wetland function, which is dependent on the area determined by the identification and delineation, attempts to describe a service or services that a wetland provides or facilitates. However, not all wetlands perform all functions, nor do they perform all functions equally well (Novitzki et al. 1996), so assessments have been developed to evaluate wetland function in individual wetlands. Some examples of ecosystem services provided by wetlands include providing important waterfowl habitat, flood mitigation, storm abatement and coastal protection, climate regulation, aquifer recharge, and water purification (Mitsch and Gosselink 2015). They have even been referred to as the “kidneys of the landscape”, noting their exceptional abilities to clean and filter water as it passes through them (Mitsch and Gosselink 2015).

Wetlands carry out so many services and functions that it can be difficult to quantify their importance. Costanza (et al. 1997) estimated the global value of the ecosystem services provided by wetlands as over $4.9 trillion per year in 1997. That dollar amount has the same buying power as over $7.3 trillion in August of 2016, according to the Bureau of Labor Statistic’s (BLS) Consumer Price Index (CPI) inflation calculator.

Wetland functions are commonly grouped into three categories: habitat, hydrologic, or water quality (Novitzki et al. 1996). Habitat functions benefit wildlife, providing food, water, and shelter for fish, shellfish, birds, and mammals (Novitzki et al. 1996). Hydrologic functions are related to the quantity of water that enters, is stored in, or leaves a wetland (Novitzki et al. 1996). These may include reducing flow velocity, groundwater recharge and discharge, as well as influencing atmospheric processes (Novitzki et al. 1996). Water quality functions include trapping sediment, pollution control, and biochemical processes (Novitzki et al. 1996).

Hydrology is the driving force in wetland functions. Because of their position on the landscape, these areas are intermittently to regularly flooded. Wetland flooding varies greatly in intensity, duration, and occurrence, even within the same site, but is the primary driver for each wetland function (Mitsch and Gosselink 2015). The functions provided by a wetland are generally not limited to the area of the individual wetland. Because they exist as embedded features on the landscape connected by hydrology, animal migration, and plant dispersal, their reach is often far beyond the hydric soil boundary (Robertson 2000).

Wetland functional assessment is currently the most important aspect of wetland science, but is the newest and least understood. No single method will probably ever satisfy all needs in wetland functional assessment (Novitzki et al. 1996); however, the development of a diversity of assessment methods allows the ecological status of the wetland resource to be reported in a variety of ways (Wardrop et al. 2007).

Functional assessments developed from a need to expedite the permitting and mitigation processes. Their goal is to accurately evaluate the existing capacity or condition for a habitat to perform individual ecosystem functions (Stein and Ambrose 1998). Many assessment techniques take into consideration the hydrological, biogeochemical, and ecological processes that occur within wetlands (Brinson et al. 1995). The results are often used in determining the potential impacts of a proposed project and its alternatives, actual impacts incurred once the project has been completed, as well as projecting future impacts on the site.

General wetland assessments and functional assessments use established knowledge about wetland ecology to form the backbone of these assessments. Many of the components of wetland assessments are based on measures that have been described as surrogates to wetland health (Balcombe et al. 2005). Because of this, some practitioners argue that many of these assessments have not properly been field validated.

The areas used in this study are alluvial valleys, often referred to as bottomland hardwood (BLH) forests. In the southeastern United States (U.S.), BLH ecosystems can be defined as wetlands that occur in floodplains and riparian corridors in association with stream channels. They are commonly found from East Texas, along the Gulf of Mexico into Florida, and north up the Atlantic coast as far as Virginia and Maryland (Brinson 1990). Many BLH forests in Texas are found within the EPA's Level III Ecoregion 35, known as the South Central Plains Ecoregion or the Pineywoods (EPA 2011). Ecoregion 35 resides in the Eastern portion of Texas where BLH make up about 15% of the region (Texas Parks and Wildlife 2007).

## Wetland Regulatory History

Wetlands have historically been viewed as a nuisance landscape element. They were known to breed diseases, inhibit travel, and restrict farming area (Dahl et al. 1996). From the beginning of American civilization wetlands have been modified and drained (Dahl et al. 1996). Due to the lack of consistent records and documents, it is difficult to determine the historical presence and organization of natural resources, such as wetlands, on the landscape (Dahl et al. 1996). Overlapping land boundaries and ownership claims were also a problem, which led to the 1785 Land Ordinance Act and established the United States Public Land Survey (Dahl et al. 1996). While the goal of this act was not to provide information on natural resource distribution, it does provide some information regarding wetlands at that time (Dahl et al. 1996).

The draining, ditching, and filling of wetlands increased exponentially in the mid-1800s as the U.S. expanded (Mitsch and Gosselink 2015). In 1849, Congress passed the first of the Swamp Land Acts, granting all swamp and overflow lands in Louisiana to the state for reclamation (Dahl et al. 1996). By 1860, 14 additional states had been included (Dahl et al. 1996). For most states, their response to the act was not immediate, but it set the tone that the federal government promoted wetland drainage and modification (Dahl et al. 1996).

In 1934, the Migratory Bird Hunting Stamp Act was passed, which was one of the first pieces of legislation to initiate acquisition and restoration of America's wetlands (Dahl et al. 1996). For every small step in the direction of wetland conservation, though, several more were taken in the opposite direction. The Watershed Protection and Flood Prevention Act of 1954 both directly and indirectly increased wetland drainage around flood-control projects (Dahl et al. 1996).

Much of the wetland losses observed in the twentieth century were due to agriculture (Dahl et al. 1996). Greater public concern for the environment in the U.S. developed in the 1960s and 1970s (Rome 2003), partly spurred by Rachel Carlson's *Silent Spring* (Carson 1962). Before this time, "wetland" was not a commonly used term (Robertson 2000). Legal protection began with the National Environmental Policy Act (NEPA) of 1969, which established a broader framework for environmental protection (Environmental Protection Agency 2015). This was followed shortly by The Convention on Wetlands of International Importance Especially as Waterfowl Habitat in 1971, which defined wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar Convention Secretariat 2013). Over the years the convention's scope of interest has broadened to nearly all aspects of wetland conservation and wise use, and is modernly referred to as the “Ramsar Convention” (Ramsar Convention Secretariat 2013).

In 1972, Section 404 of the Federal Water Pollution Control Act (FWPCA) was implemented, later more commonly referred to as the Clean Water Act (CWA), monitoring “dredge and fill” activities in Waters of the United States (WOTUS). This includes jurisdictional wetlands that are adjacent to, or have a nexus to, WOTUS. While Section 404 kept wetlands from being filled without a proper permit, it did not explicitly protect them (Robertson 2000). The 1977 amendments to the CWA were first interpreted to pertain to wetlands and protected them.

Wetlands were first acknowledged as an important part of the hydrologic cycle at a wetland conference in 1973, and in 1977 the first National Wetland Protection Symposium was held (Novitzki et al. 1996).

The U.S. Fish & Wildlife Service (USFWS) has been developing habitat-based evaluation methods since 1974, culminating in the general handbook for the Habitat Evaluation Procedures being published in 1976 (U. S. Fish and Wildlife Service 1980). It has been since updated and re-published in 1980. These models are species-specific, including wetland-dependent species such as wood duck (*Aix sponsa*) (Sousa and Farmer 1983). A model is developed for assessing the suitability of an area for the target species based on predetermined life requisites. This is the Habitat Suitability Index, or HSI. Examples of other species with HSI models are fox squirrel (*Sciurus niger*) (Allen 1982), beaver (*Castor canadensis*) (Allen 1983), downy woodpecker (*Picoides pubescens*) (Schroeder 1982), and the Greater Sandhill Crane (*Grus canadensis tabida*) (Armbruster 1987).

In 1977, President Jimmy Carter signed Executive Order 11988 – Floodplain Management and Executive Order 11990 – Protection of Wetlands into effect (Votteler and Muir 1996). The goal of these orders is to ensure protection and proper management of floodplains and wetlands by federal agencies (Votteler and Muir 1996). While it did not totally prevent the destruction of wetlands, it set the goal to avoid negative impacts to wetlands when there is a practical alternative. This was the beginning of a common principle used today know as avoid, minimize, and mitigate.

The unique qualities of wetlands and a list of their functions were developed at a Wetland Values and Management Conference in 1981 (Novitzki et al. 1996). Not only did the list include the commonly recognized wildlife habitat functions of wetlands, but recognized their hydrologic and water quality functions (Novitzki et al. 1996).

The Wetland Evaluation Technique (WET) was developed by Adamus in 1983 and revised by the USACE in 1987 (Adamus and Stockwell 1983; Novitzki et al.

1996). It defines wetland functions as the physical, chemical, and biological characteristics of a wetland (Novitzki et al. 1996). The WET evaluates wetland functions and values in terms of effectiveness, opportunity, social significance, and habitat suitability (Novizki et al. 1996).

The Food Security Act of 1985 or “Swampbuster” reduces farming program benefits if wetlands are converted for agricultural use (Wilen et al. 1996). The Swampbuster was amended by the Food, Agriculture, Conservation and Trade Act of 1990 to create the Wetland Reserve Program, which not only reduced benefits for using wetlands as croplands but provided incentive to farmers for wetland restoration and protection through long-term easements (Votteler and Muir 1996).

The Emergency Wetland Resources Act of 1986 established and defines the responsibilities of the National Wetlands Inventory (Wilen et al. 1996). It is tasked with producing detailed maps on the characteristics and extent of the nation’s wetlands, constructing a national wetlands database, disseminating wetland maps and digital data, report the results of state wetland inventories, report to Congress every ten years on the status and trends of the nation’s wetlands, and assemble and distribute wetland maps, data, and reports (Wilen et al. 1996). The National Wetlands Inventory currently has one of the most comprehensive digital databases of wetland and water resource features.

The USACE defined wetlands in 1987 in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) as, "*Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas*" (Environmental Laboratory 1987). The 1987 delineation manual (Environmental Laboratory 1987) provides guidelines on the methodology used to determine and delineate a potential jurisdictional wetland area. Regional supplements to the delineation manual have been developed for specific areas within the country, such as the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (U.S. Army Corps of Engineers 2010), which is applicable to the study area of this project.

The Environmental Monitoring Assessment Program – Wetlands, or EMAP – Wetlands, began in 1988 by the U.S. EPA (Novitzki et al. 1996). It was intended to be an approach for assessing the condition of different types of wetlands in a region as well as the nation as a whole (Novitzki et al. 1996). The goal of EMAP – Wetlands was to conduct research to identify "indicators" of wetland condition, standardize methods of measurement, and establish a network for monitoring wetlands at regional scales and over long periods of time (Novitzki et al. 1996).

To help with the identification of wetlands in the U.S., in 1988 the U.S. Fish & Wildlife Service created a list of wetland plants, and in 1991 the U.S. Soil Conservation Service (National Resources Conservation Service as of 1994) developed a list of hydric soils (Tiner 1996). These lists are now managed by the USACE.

The concept of the "no net loss" policy was again introduced at the National Wetlands Policy Forum in 1987, and was adopted by President George H. W. Bush in 1989.

"…I want to ask you today what the generations to follow will say of us 40 years from now. It could be they'll report the loss of many million acres more, the extinction of species, the disappearance of wilderness and wildlife; or they could report something else. They could report that sometime around 1989 things began to change and that we began to hold on to our parks and refuges and that we protected our species and that in that year the seeds of a new policy about our valuable wetlands were sown, a policy summed up in three simple words: 'No net loss.'"

- President George H. W. Bush, speaking to Ducks Unlimited, June 8, 1989 (United States Government Printing Office 1990)

This policy is significant because it provides a compromise between development and conservation. It does not strictly forbid the destruction or use of wetlands, but requires that the net function of wetland areas be maintained or improved through conservation and mitigation techniques. “No net loss” advanced the idea of wetlands as a homogenous entity, contributing to the development of more broadly consistent definitions and identification methods among government agencies (Robertson 2000). However, one issue with this policy, as pointed out by Robertson (2000), is that nature has become a commodity that is able to be sold at a price signifying the value of its goods. This “nature commodity” system has led to mitigation complications and often over simplification of the resources wetlands provide.

## Assessment Method Development

The Hydrogeomorphic (HGM) Approach was developed 1990 as a way to assess the physical, chemical, and biological functions of wetlands (Novitzki et al. 1996). It is a revision and simplification of the earlier WET method, and was intended to be more applicable to specific regions (Novitzki et al. 1996).

Texas Parks and Wildlife (TPW) released the current Wildlife Habitat Appraisal Procedures (WHAP) in 1995 (Texas Parks and Wildlife 1995). This method is intended to evaluate wildlife habitat “without imposing significant time requirements” (Texas Parks and Wildlife 1995). It uses components that contribute to ecological condition, and also allows for calculating mitigation requirements. This method does not attempt to evaluate habitat quality for specific species.

The USACE developed a national HGM guidebook for assessing wetland condition in riverine and tidal fringe wetlands in 1995 (Brinson et al. 1995) and 1998 (Shafer and Yozzo 1998), respectively. The first regional HGM guidebook was then released in 1999 for low-gradient riverine wetlands in Western Kentucky (Ainslie et al. 1999).

The 2008 Compensatory Mitigation Rule clearly outlines the requirements of "avoid, minimize, compensate (or mitigate)". If the projects and related impacts are proven unavoidable, the loss of wetland area and function must be replaced. The required steps must be taken to minimize adverse impacts "to the extent appropriate and practical". Compensation requirements can then be completed in the form of wetland restoration, establishment, enhancement, or preservation.

The Texas Rapid Assessment Method (TXRAM) Version 1.0 was published in 2011, and Version 2.0 was published in 2015. It is designed to be a rapid assessment technique for evaluating the ecological conditions of jurisdictional wetlands and streams (U.S. Army Corps of Engineers 2015).

The East Texas HGM Guidebook was released in 2010, while the Southeastern United States HGM Guidebook was released in 2013. It differs from TXRAM in that it calculates a functional condition for specific ecological functions, rather than calculating one score for the site as a whole.

## Wetland Determination

The 1987 Delineation Manual (Environmental Laboratory 1987) was developed by the USACE Environmental Laboratory at the Waterways Experiment Station due to a lack of formal rules for wetland delineation. It was in development for several years and multiple draft versions were tested before the release of this manual. It is a technical manual that provides guidance on how to use the three wetland parameters to identify and delineate wetland boundaries (Votteler and Muir 1996). This manual determines or delineates a wetland according to the purposes of Section 404 of the Clean Water Act (Environmental Laboratory 1987).

The regional supplements were created to address regional wetland characteristics as well as increase the accuracy and efficiency of wetland delineation. The Atlantic & Gulf Coastal Plain supplement (U.S. Army Corps of Engineers 2010) covers the southeast region of the U.S. from Texas, to Florida, to New Jersey, and is applicable to the proposed study area. There are nine additional supplements covering the continental U.S., Alaska, the Caribbean, and Hawaii and the Pacific Islands.

The regional supplement is designed to work alongside the current version of the original delineation manual. Due to regional specificity, anywhere the nationwide manual and regional supplement differ, the regional supplement takes precedence.

## Hydrogeomorphic Approach (HGM)

The Hydrogeomorphic Approach was also developed by the USACE beginning in 1990. The WET was published and revised in 1983 & 1987, respectively. EMAP – Wetlands was also introduced the following year in 1988. HGM research began in 1990, and was first released in 1995 (Smith et al. 1995). The national riverine HGM guidebook was then released later in 1995 (Brinson et al. 1995). A national guidebook for tidal fringe wetlands was published in 1998 (Shafer and Yozzo 1998). The first regional HGM guidebook was published in 1999 for riverine wetlands in western Kentucky (Ainslie et al. 1999).

The concept of a rapid assessment procedure was mentioned in HGM documents in 1997 (Natural Resources Conservation Service 2008), but there was some discrepancy over what was meant by “rapid”. Smith and Wakely (2001) defined it as being able to complete the field work required for the assessment in a day or less. Then Clairain (2002) stated it as being implemented efficiently within the time and resources available to personnel when making regulatory decisions. Overall, these rapid methods must be relatively quick, accurate, and have the ability to be validated through more intense field methods (Fennessy et al. 2007).

HGM was designed to meet the need for assessment methods that support sound decisions about compensatory mitigation, acquisition, restoration, and impact assessment (Hruby 1999). It estimates the capacity of an individual wetland to perform a suit of hydrologic, biogeochemical, and habitat functions through the use of multiple criteria assessment models (Smith and Wakeley 2001). HGM is limited to a subclass, and therefore not sufficient for ecosystem scale monitoring projects (Natural Resource Conservation Service 2008).

HGM assessment uses a suite of mathematical models to estimate the magnitude at which a wetland performs a suite of ecological functions associated with a specific wetland subclass (Smith and Wakeley 2001). Regional guidebooks may require different levels of field data collection depending on the functions being assessed, therefore a “target” function can be used in regards to the policy being fulfilled, such as functions based on habitat suitability or plant communities. Currently, two national and twenty-eight regional guidebooks exist.

HGM differs from other wetland assessment methods in three primary ways (Clairain 2002). First, wetlands are classified based on ecological characteristics such as geomorphic setting, water source, and hydrodynamics. Second, multiple criteria assessment models are used to estimate the functional capacity of a wetland in a specific subclass.  Third, reference wetlands are used to scale the capacity of any given wetland to perform a function.  HGM employs a “reference standard”, or an area of highest condition within the reference domain. Reference data are collected across a gradient of wetland condition to calibrate field measurements.

One shortfall of HGM is its lack of validation.  While the models are calibrated to field data sets, there have been no true validation efforts (Cole 2015).  This shortcoming is not unique to HGM, though, as Cole (2015) points out that most rapid wetland assessments have the same flaw in that they rely upon indicators developed from assumptions based on literature reviews.  Dvorett (2013) also concluded that HGM is calibrated to some natural disturbances, but its use in sensing anthropogenic disturbance is limited.

HGM was used by Wardrop (et al. 2007) to determine the ecological status of wetlands in the Upper Juanita watershed in Pennsylvania based on models developed by Brooks (et al. 2004).  The unique aspect of this study is the extension of the HGM models at the watershed level.  It also claimed to help validate the HGM process, but Cole (2015) stated that it only calibrated the model, not validated it.

Southeast HGM (SEHGM)

The Southeast regional HGM guidebook was published in 2013 (Wilder et al. 2013) and is based on the 1995 national riverine guidebook (Brinson et al. 1995). It has a large geographic domain, reaching from East Texas, along the Mississippi River in Arkansas, Louisiana, and Mississippi, and along the east coast to North Carolina and Virginia.

The SEHGM has datasheets for headwater slopes, mid- and low-gradient riverine systems, and connected depressions.  It assesses functions for maintaining characteristic hydrology, elemental transformation and cycling, maintaining characteristic plant community, and providing characteristic wildlife habitat.

East Texas HGM (ETXHGM)

The East Texas regional HGM guidebook was published in 2010 (Williams et al. 2010) and is based on the 1995 national riverine guidebook (Brinson et al. 1995).  Its reference domain is the Pineywoods Ecoregion of Texas.  It is very similar in field metrics and function calculation to the Southeast regional HGM guidebook, but it requires several additional metrics to be measured in the field.

ETXHGM has datasheets for low- and mid-gradient riverine and connected depressions.  Functions assessed for the riverine class are: detain floodwater, detain precipitation, cycle nutrients, export organic carbon, maintain plant communities, and provide habitat for fish and wildlife. The connected depressions class does not evaluate detain precipitation.

## Texas Rapid Assessment Method (TXRAM)

TXRAM was developed by the USACE for use in the Fort Worth District of Texas (see Figure 16 in the Appendix, page 149). This area includes sections of EPA level III ecoregions 1-9 and the entirety of Nacogdoches County. The TXRAM manual was first published in 2011, and version 2.0 was published in 2015.

It applies to both wetlands and streams, but it is discussed as applicable to wetlands. The goal of TXRAM, as the name suggests, is to provide a quick and field-based method of quantitatively assessing wetland integrity and health that can be repeated consistently. It is intended for use in jurisdictional wetlands to calculate negative impacts and mitigation requirements due to activities authorized under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.

This process can be used to evaluate a potential impact, compare impacts of project alternatives, and/or track changes in condition over time to keep up with monitoring requirements. TXRAM credits a single, overall score to the assessed area. The simplicity of it can be helpful in theory; however, it leaves out the evaluation of specific ecological functions and societal importance. Additionally, it is only meant to be used to compare like wetland types and wetlands within the same ecoregion.  Similar to HGM, TXRAM does employ a “reference standard”, or an area of highest condition within the reference domain that has been used to set standards in scoring.

Few rapid assessment protocols have been calibrated with intensive data sampling, but the Ohio Rapid Assessment Method and the California Rapid Assessment Method, as well as a RAM for the Juanita watershed in Pennsylvania have been validated (Stein et al. 2009).  TXRAM has not currently been validated as intensely as the ORAM and CRAM assessments, but the success of the other systems shows its potential.

In 2009, Stein (et al.) published a case study to validate the riverine and estuarine modules of the California Rapid Assessment Method (CRAM).  Many aspects of it were evaluated and existing data on avian diversity and other organisms were used for validation.  It was found that overall CRAM is effective in assessing general riverine and estuarine wetland condition based on correspondence with other independent assessments of condition.  The largest issue found during the validation was in reproducibility (Stein et al. 2009). However, by revising some ambiguous language in the metric description as well as the measurement of some metrics, the error rate was reduced considerably (Stein et al. 2009).

Fennessy (et al. 2004) published a review of rapid methods for assessing wetland condition.  TXRAM was not included specifically, but several of the other state RAM models were.  According to Fennessy, in order to be used as a sufficient rapid assessment, four criteria should be met (et al. 2004).  The method needs to be able to measure condition, needs to actually be “rapid”, needs to be an on-site assessment, and needs to be able to be verified (Fennessy et al. 2004).

In total, forty-one methods were originally considered for study but twenty-five were eliminated on the basis of not being truly rapid.  The remaining sixteen were left for a more detailed analysis based on the four criteria.  For each method, it was determined whether or not they assess condition, the types of wetlands they can be used to assess, how long they take to perform, and the pros and cons of each one.

Only seven methods were found to have potential for use in developing and implementing wetland monitoring and assessment programs.  These are the draft Delaware Method, the Florida Wetland Rapid Assessment Procedure (FWRAP), Massachusetts Coastal Zone Management Method, Montana Method, Ohio Rapid Assessment Method (ORAM), the Penn State Stressor Checklist, and the Washington State Wetland Rating System – Western.

Some issues still arise with the use of rapid assessments. For example, there still may be variation in the definition of the wetland assessment area. It may include the entire wetland, a homogenous section of it, or both depending on the application (Fennessy et al. 2004). There is also confusion with different versions of the same method for use in various wetland classes. While it would be helpful to have the consistency of using the same version of a form for all wetland types in a region, it is important to note that different classes can respond very differently. However, review of the methods also lead to the conclusion that “clumping” different classes may not lose much information overall (Fennessy et al. 2004). Additionally, the value of a single ecological condition score for the site versus individual function scores can be debated. Individual functions may not be as sensitive as they appear, and using categorical scoring has proven to be more effective (i.e. high = 20-30ft, med = 10-20ft, low = 0-10ft) (Fennessy et al. 2004).

An understanding of wetland formation and maintenance, as well as knowledge of wetland indicators, is helpful in the development of assessment methods. Rapid methods are most effective when based off of the processes that create, maintain, and degrade wetlands. They need to be both scientifically sound and cost and time efficient.

## Wildlife Habitat Appraisal Procedure

The U.S. Fish & Wildlife Service began developing the Habitat Evaluation Procedures (HEP) in 1974 and published the first models in 1976. HEP is a species-specific assessment that is still currently being used to assess both wetland and upland areas. HEP is intended to document the quality and quantity of available habitat for selected wildlife species (U. S. Fish and Wildlife Service 1980). Models developed for HEP need to be validated and used to assess only the appropriate areas. Additionally results obtained by the HEP model can only be applied to that species (Rigard 2010). Some general observations may be extrapolated to species with similar life requirements, but the results cannot be extended to all species (Rigard 2010).

In 1995 Texas Parks and Wildlife published the Wildlife Habitat Appraisal Procedures (WHAP). WHAP is a generalized version of HEP and is only applicable in the state of Texas. While HEP models are carefully validated and used in specific areas, WHAP is much more generalized and has a wide geographic domain to ease use and increase efficiency. This method is intended to evaluate wildlife habitat as a truly rapid assessment “without imposing significant time requirements” (Texas Parks and Wildlife 1995). It uses components that contribute to ecological condition, and also allows for calculating mitigation requirements. These metrics are an important part of the study because vegetation communities are known to have direct effects on the distribution and abundance of wildlife populations (Balcombe et al. 2005). This method does not attempt to evaluate habitat quality for a specific species.

## Comparison

Literature pertaining to the direct comparison of wetland functional assessment methods is scarce. There are several studies that “review” wetland assessment methods, but the focus is usually on field techniques, reproducibility, and other information. There is little research comparing the actual scores obtained by these various methods. One of the most direct comparison applications was published by Krauss (2013). It was found that the use of multiple assessment methods on the same project can lead to highly variable results. The impacts to wetlands were assessed by a ratio of the number of acres impacted and the ecological offsets, and the ratio of offsets to impacts varied from 1.5:1 to 3:1. A baseline of $20,000 per mitigation acre was used for comparison purposes. Comparing the use of the Charleston Method, Modified Charleston Method, HGMi, and TXRAM led to an estimated cost per impact acre ranging from $12,000 to $72,000. Use of the Charleston method in the Vicksburg district calculated a cost per impact acre of $72,000 with an offset/impact ratio of 3.6:1. The modified Charleston method in the New Orleans district was $48,000 per impact acre (2.4:1), the HGMi in the Galveston district was $15,000 per impact acre (0.7:1), and TXRAM in the Fort Worth district was

$12,000 per impact acre (0.6:1). Due to this variability, it is important to thoroughly evaluate all project implications to ascertain that mitigation requirements are sufficient. An estimate that is too high is costly and wasteful, while an underestimated mitigation requirement can be even more costly due to late penalties and lengthened legal activities.

# METHODS OF STUDY

## Sample Areas

Sampling took place within the East Texas area on a total of five different locations. The five selected sites were: The Lake Naconiche Mitigation Area in Angelina County, TX (Site 1), the Stephen F. Austin Experimental Forest in Nacogdoches County, TX (Site 2), Alazan Wildlife Management Area in Nacogdoches County, TX (Site 3), Boggy Slough Conservation Area in Trinity County, TX (Site 4), and a privately-owned tract of land near Sacul, TX, in Nacogdoches County, TX (Site 5). The general location of these sites is shown in Figure 12 in the Appendix, page 145. Each of these sites supported mature bottomland hardwood forests, apart from Site 5, which was mature and forested, but then was clear-cut several days before sampling took place. “Mature” forests may exhibit characteristics such as multi-layered canopies, canopy gaps, varying sizes of woody debris, large trees, standing snags (dead trees), a mix of tree ages, and a thick layer of organic matter on the soil surface. Site 5 was thus a disturbed site. Sites 1-4 met the Cowardin classification of PFO1A, PFO1C, PFO1F, etc (Cowardin et al. 1979). This means the sites were palustrine, forested, broad-leaved deciduous and either temporarily, seasonally, or semi-permanently flooded. At each site, ETXHGM, SEHGM, WHAP, and TXRAM were performed at five randomly selected locations.

Each assessment has a geographic domain intended for its use. The Atlantic and Gulf Coastal Plain regional supplement for determination (U.S. Army Corps of Engineers 2010) has the geographic domain pictured in Figure 13 in the Appendix, page 146. The SEHGM guidebook (Wilder et al. 2013) is applicable to the area shown in Figure 14 in the Appendix, page 147. The WHAP method has a geographic domain of the entire state of Texas. The ETXHGM guidebook (Williams et al. 2010) is applicable to the area shown in Figure 15 in the Appendix, page 148. The TXRAM manual (U.S. Army Corps of Engineers 2015) has a geographic domain corresponding to the boundary of the USACE Fort Worth District, as shown in Figure 16 in the Appendix, page 149.

The smallest geographic domain is the EPA level III Pineywoods Ecoregion of Texas, which is the geographic domain of the East Texas HGM guidebook (see Figure 15 in the Appendix, page 148). All sampling occurred within this ecoregion. All sites fulfilled the requirements for low gradient riverine (ETXHGM) or riverine (SEHGM, TXRAM). WHAP does not vary its approach among wetland classes.

A 1/10 acre plot was used for all field metrics that required plot-based sampling.

Data from the National Wetlands Inventory (NWI) was used to guide the selection of sampling locations that were in the PFO1X classification. The locations were then field-verified by the author and contributors. Field data collection was performed during the spring and summer of 2017.

## Determination

Two wetland determination forms (for examples see Figure 17a-Figure 17c in the Appendix, pages 150-152) were completed in accordance with the USACE Atlantic and Gulf Coastal Plain regional supplement (U.S. Army Corps of Engineers 2010) on each site to ascertain that the area meets the parameters of a potential jurisdictional wetland. The determination procedure was performed at the two locations that were geographically farthest apart. This determination procedure takes into account vegetation, soils, and hydrology. It was not necessary to complete a wetland determination datasheet at each sampling plot, as the communities were relatively homogenous.

For wetland determination, a 1/10 acre plot was evaluated for hydrology indicators and vegetative cover. A soil characterization was also performed to ascertain if the soils had hydric indicators. Photos were taken at each plot and site. Vegetation was evaluated through a tree count by species at each plot, as well as percent cover of all strata.

Equipment needed for determination included pin flags, 75-foot loggers tape, compass, sharpshooter, Munsell Soil Color Book, and a folding rule.

## SEHGM

Sampling was followed as outlined in the Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in Alluvial Valleys of the Southeastern Coastal Plain of the United States (Wilder et al. 2013), or SEHGM Guidebook. The datasheets for low- and mid-gradient riverine were used (for examples see Figure 18a-Figure 18d in the Appendix, pages 153-156).

Variables measured for this assessment include $V_{CONNECT}$ (habitat connections), $V_{SOILINT}$ (soil integrity), $V_{HYDROSYS}$ (system hydrologic alterations), $V_{HYDROALT}$ (site hydrologic alterations), $V_{BIG3}$ (canopy tree diameters), $V_{CTDEN}$ (canopy tree density), $V_{SSC}$ (sapling/shrub cover), $V_{GVC}$ (ground vegetation cover), $V_{WD}$ (woody debris), and $V_{COMP}$ (vegetation composition and diversity).

$V_{CONNECT}$ (habitat connections), $V_{SOILINT}$ (soil integrity), $V_{HYDROSYS}$ (system hydrologic alterations), and $V_{HYDROALT}$ (site hydrologic alterations) can be evaluated through Geographic Information Systems (GIS) analysis or site history and then field-verified.

$V_{BIG3}$ (canopy tree diameter), $V_{CTDEN}$ (canopy tree density), $V_{SSC}$ (sapling/shrub cover), $V_{GVC}$ (ground vegetation cover), $V_{WD}$ (woody debris), and $V_{COMP}$ (vegetation composition and diversity) were measured directly in the field.

HGM employs both site-level and plot-level variables. Site-level metrics were recorded once for the entire wetland assessment area, or WAA. Plot-level metrics were then evaluated in each 1/10 acre plot, so they may vary within a site. Site-level variables for this method are $V_{CONNECT}$, $V_{SOILINT}$, $V_{HYDROSYS}$, and $V_{HYDROALT}$. The remaining variables were assessed at the plot level.

This method used a 1/10 acre fixed plot set up as shown in the diagram in Figure 19 in the Appendix, page 157. Equipment needed for the SEHGM assessment included pin flags, 75-foot loggers tape, diameter tape, and a folding rule.

This method results in the calculation of a score between 0.00-1.00 for the following functions: maintain characteristic hydrology, elemental transformation and cycling, maintain characteristic plant community, and provide characteristic wildlife habitat.

The maintain characteristic plant community and provide characteristic wildlife habitat functions were primarily used for analysis.

ETXHGM

Sampling was followed as outlined in the Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas (Williams et al. 2010), or ETXHGM Guidebook. The datasheets for low-gradient riverine were used (for examples see Figure 20a-Figure 20c in the Appendix, pages 158-160).

Variables measured in this assessment include $V_{PATCH}$ (forested patch size), $V_{FREQ}$ (flood frequency), $V_{DUR}$ (flood duration), $V_{POND}$ (percent of the area capable of ponding water), $V_{STRATA}$ (number of vegetative strata present), $V_{SOIL}$ (percent of site with significantly altered soils), $V_{TBA}$ (tree basal area), $V_{TDEN}$ (tree density), $V_{SNAG}$ (snag density), $V_{OHOR}$ (O horizon depth), $V_{AHOR}$ (A horizon depth), $V_{TCOMP}$ (tree composition), $V_{SSD}$ (sapling shrub density), $V_{GVC}$ (percent ground vegetation cover), $V_{LITTER}$ (percent ground litter cover), $V_{LOG}$ (log biomass), and $V_{WD}$ (woody debris biomass).

$V_{PATCH}$ (forested patch size), $V_{FREQ}$ (flood frequency), $V_{DUR}$ (flood duration), $V_{SOIL}$ (percent of site with significantly altered soils), and $V_{AHOR}$ (A horizon depth) can be evaluated through GIS analysis or site history and then field-verified.

$V_{POND}$ (percent of the area capable of ponding water), $V_{STRATA}$ (number of vegetative strata present), $V_{TBA}$ (tree basal area), $V_{TDEN}$ (tree density), $V_{SNAG}$ (snag density), $V_{OHOR}$ (O horizon depth), $V_{TCOMP}$ (tree composition), $V_{SSD}$ (sapling shrub density), $V_{GVC}$ (percent ground vegetation cover), $V_{LITTER}$ (percent ground litter cover), $V_{LOG}$ (log biomass), and $V_{WD}$ (woody debris biomass) were directly measured in the field.

HGM employs both site-level and plot-level variables. Site-level metrics were recorded once for the entire WAA. Plot-level metrics were then evaluated in each 1/10 acre plot, so they may vary within a site. Site-level variables for this method are $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, $V_{STRATA}$, and $V_{SOIL}$. The remaining variables were assessed at the plot level.

This method used a 1/10 acre fixed plot set up as shown in the diagram in Figure 21 in the Appendix, page 161. Equipment needed for the ETXHGM assessment included pin flags, 75-foot loggers tape, 10-factor prism, folding rule, and a sharpshooter.

This method results in the calculation of a score between 0.00-1.00 for the following functions: detain floodwater, detain precipitation, cycle nutrients, export organic carbon, maintain plant communities, and provide habitat for fish and wildlife.

The maintain plant communities and provide habitat for fish and wildlife functions were primarily used for analysis.

## TXRAM

Sampling was followed as outlined in The Texas Rapid Assessment Method Wetlands and Streams Modules (U.S. Army Corps of Engineers 2015), or TXRAM. The wetlands module datasheets were used in this assessment (for examples see Figure 22a-Figure 22b in the Appendix, pages 162-163).

Variables used in the assessment were: aquatic context, buffer type, water source, hydroperiod, hydrologic flow, organic matter in soils, sedimentation, soil modification, topographic complexity, edge complexity, physical habitat richness, plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations.

Many of these variables can be evaluated through GIS analysis or site history and then field-verified. All other variables were directly measured in the field. This method results in the calculation of a single score between 0-100 of wetland condition.

## WHAP

Sampling was followed as outlined in the Wildlife Habitat Appraisal Procedures (Texas Parks and Wildlife 1995). There is only one datasheet option (for examples – see Figure 23 in the Appendix, page 164).

Variables measured for this assessment were: site substrate, stand age, uniqueness and relative abundance, diversity of woody species, total number of occurring woody species, vertical vegetation stratification, structural diversity components, degree of utilization of woody vegetation by vertebrates and invertebrates, and availability of herbaceous vegetation.

Site substrate, stand age, uniqueness and relative abundance, diversity of woody species, total number of occurring woody species, vertical vegetation stratification, structural diversity components, degree of utilization of woody vegetation by vertebrates and invertebrates, and availability of herbaceous vegetation were all measured directly in the field. Variables such as stand age and uniqueness can be hypothesized in the office, but still required field verification.

This method suggests a sample area large enough to provide an “adequate representation” of woody and herbaceous species, or approximately 0.5 acres. Plot center was the same as the 1/10 acre plots, but sampling for this method extended to the observable area.

This method results in the calculation of a single score between 0-100 of habitat quality.

## Analysis

The following hypothesis was tested at a Type I error of 0.05 ($\alpha = 0.05$):

$H_o$: All four assessment methods will result in similar functional capacity scores

$H_a$: All four assessment methods will not result in similar functional capacity scores

Once all field data were collected, the site scores for TXRAM, ETXHGM, SEHGM, and WHAP were standardized to a single number between 0.00 and 1.00. TXRAM scores were divided by 100 to achieve a score between 0.00-1.00. The data was analyzed as a completely randomized design one-way analysis of variance (ANOVA) (see Table 1, below page 42).

Each site was a replication (five total) and each method was a treatment (four total). A total of five locations were sampled at each of the five sites, resulting in 25 total observations per treatment, or assessment method. The analysis was a comparison between techniques, and not sites. If results were significant, a grouping such as the Student-Newman-Keuls (SNK) and Tukey test was used to determine if the resulting scores were statistically similar. Analysis was done using SAS version 9.4.

Table 1. Example One-Way ANOVA table for determining significance of the data.

| Source of Variance | Degrees of Freedom |
|---|---|
| Treatment (Assessment method) | 4-1=3 |
| Error | 4(5-1)=16 |
| Total | (4*5)-1=19 |

# RESULTS

## Site Description

Lake Naconiche Mitigation Area

The Lake Naconiche Mitigation Area is located adjacent to the Angelina River where it crosses State Highway 7 West (see Figure 24 in the Appendix, page 165). It is in Angelina County, TX, and was sampled on March 15, 2017, by A. Camp, W. Johnson, and S. Singletary. The soil series in the area is a Mantachie clay loam, frequently flooded. This series has a taxonomic classification of fine-loamy, siliceous, acid, thermic Aeric Fluvaquent. It is rated as a hydric soil. All sample points were in this soil series, although plot 1 did come close to the border of the Marietta fine sandy loam, occasionally flooded soil series (see Figure 25 in the Appendix, page 166). This series has a taxonomic classification of fine-loamy, siliceous, thermic Fluvaquentic Eutrochrepts. It is not rated as a hydric soil.

This site had areas with a National Wetlands Inventory rating of PFO1A, PFO1C, and PFO1F, or palustrine, forested, broad-leaved deciduous wetlands that are flooded temporarily, seasonally, or semi-permanently. Plot 1 was classified as PFO1C according to NWI, and plots 2-5 were classified as PFO1/SS1A (see Figure 26 in the Appendix, page 167).

Five sample points were used in total. The sampling points ranged from approximately 125 – 400 m from the main channel of the Angelina River. Sampling point coordinates were as follows:

Table 2. Coordinates of the five sampling points assessed within Site 1, Lake Naconiche Mitigation Area.

| | Longitude | Latitude |
|---|---|---|
| Plot 1 | -94.82694444 | 31.48583333 |
| Plot 2 | -94.82694444 | 31.48722222 |
| Plot 3 | -94.82944444 | 31.48861111 |
| Plot 4 | -94.82666667 | 31.48750000 |
| Plot 5 | -94.82638890 | 31.48694440 |

Stephen F. Austin Experimental Forest

The Stephen F. Austin Experimental Forest is located in Nacogdoches County, TX, between State Highway 7 and US Highway 59 (see Figure 27 in the Appendix, page 168). It is bordered on the south by the Angelina River. This location was sampled on April 13, 2017, by A. Camp and S. Singletary. The soil series in the area is the Angelina soils, frequently flooded. This series has a taxonomic classification of fine-loamy, siliceous, acid, thermic Typic Fluvaquent. It is rated as a hydric soil. All sample points were in this soil series, although plots 3-5 did come close to the border of the Woden fine sandy loam, 1 to 4% slopes, soil series (see Figure 28 in the Appendix, page 169). This series has a taxonomic classification of coarse-loamy, siliceous, thermic, Typic Paleudalf. It is not rated as a hydric soil.

This site had areas with a National Wetlands Inventory rating of PFO1A and PFO1F, or palustrine, forested, broad-leaved deciduous wetlands that are flooded temporarily or semi-permanently. Plots 2, 4, and 5 were classified as PFO1F according to NWI, and plots 1 and 3 were classified as PFO1A (see Figure 29 in the Appendix, page 170).

Five sample points were used in total. The sampling points were approximately 2,000 m from the main channel of the Angelina River. Sampling point coordinates were as follows:

Table 3. Coordinates of the five sampling points assessed within Site 2, Stephen F. Austin Experimental Forest.

| | Longitude | Latitude |
|---|---|---|
| Plot 1 | -94.76444444 | 31.49527778 |
| Plot 2 | -94.76388889 | 31.49416667 |
| Plot 3 | -94.76333333 | 31.49305556 |
| Plot 4 | -94.76222222 | 31.49194444 |
| Plot 5 | -94.76083333 | 31.49166667 |

Alazan Wildlife Management Area

The Alazan Wildlife Management Area is located just east of the Stephen F. Austin Experimental Forest in Nacogdoches County, TX. It is north of the Angelina River and west of US Highway 59 south (see Figure 30 in the Appendix, page 171). This location was sampled on April 17, 2017, by A. Camp and S.

Singletary. The soil series in the area is a Mantachie soils, frequently flooded. This series has a taxonomic classification of fine-loamy, siliceous, acid, thermic Aeric Fluvaquent. It is rated as a hydric soil. All sample points were in this soil series, although plot 5 did come close to the border of the Tuscosso Clay Loam, frequently flooded soil series (see Figure 31 in the Appendix, page 172). This series has a taxonomic classification of fine, mixed, thermic Dystric Fluventic Eytrochrepts. It is not rated as a hydric soil.

This site had areas with a National Wetlands Inventory rating of PFO1A, PFO1C, and PFO1F, or palustrine, forested, broad-leaved deciduous wetlands that are flooded temporarily, seasonally, or semi-permanently. Plots 1 and 3 were within PFO1A according to NWI, plot 2 borders on PFO1A and PFO1F, plot 5 was classified as PFO1C, and plot 4 was outside of the NWI polygon (see Figure 32 in the Appendix, page 173). Although plot 4 was outside of the NWI polygon, field verification showed that it still exhibited the characteristics of a wetland.

Five sample points were used in total. The sampling points ranged from approximately 900 – 1,500 m from the main channel of the Angelina River. Sampling point coordinates were as follows:

Table 4. Coordinates of the five sampling points assessed within Site 3, Alazan Wildlife Management Area.

| | Longitude | Latitude |
|---|---|---|
| Plot 1 | -94.75027778 | 31.47722222 |
| Plot 2 | -94.75083333 | 31.47805556 |
| Plot 3 | -94.75083333 | 31.48000000 |
| Plot 4 | -94.75194444 | 31.48222222 |
| Plot 5 | -94.74861111 | 31.48277778 |

Boggy Slough Conservation Area

The Boggy Slough Conservation Area is located west of Lufkin, TX, along State Highway 94 west in Trinity County, TX. It is bordered on the east by the Neches River (see Figure 33 in the Appendix, page 174). The location was sampled on May 8, 2017, by A. Camp and J. Grogan. The soil series in the area is the Ozias-Pophers complex, 0 to 1% percent slopes, frequently flooded soil series. The Ozias series has a taxonomic classification of fine, smectitic, thermic Aeric Dystraquert. The Pophers series has a taxonomic classification of fine-silty, siliceous, active, acid, thermic Fluvaquentic Endoaquepts. Both soils are rated as hydric soils. All sample points were in this soil complex, although plot 5 did come close to the border of the Hainesville loamy fine sand soil series (see Figure 34 in the Appendix, page 175). This series has a taxonomic classification of thermic, coated Lamellic Quartzipsamments. It is not rated as a hydric soil.

This site had areas with a National Wetlands Inventory rating of mostly PFO1A and some PFO1C, palustrine, forested, broad-leaved deciduous wetlands that are flooded temporarily or seasonally. Plots 1-4 were classified as

PFO1A according to NWI, and plot 5 was outside of the NWI polygons (see Figure 35 in the Appendix, page 176). Although plot 5 was outside of the NWI polygon, field verification showed that it still exhibited the characteristics of a wetland.

Five sample points were used in total. The sampling points ranged from approximately 70 – 250 m from the main channel of the Neches River. Sampling point coordinates were as follows:

Table 5. Coordinates of the five sampling points assessed within Site 4, Boggy Slough Conservation Area.

| | Longitude | Latitude |
|---|---|---|
| Plot 1 | -94.90056667 | 31.30500000 |
| Plot 2 | -94.89889000 | 31.30722000 |
| Plot 3 | -94.90139000 | 31.31028000 |
| Plot 4 | -94.90111000 | 31.31472000 |
| Plot 5 | -94.89972000 | 31.32694000 |

Sacul, TX

The privately-owned tract of land near Sacul, TX, is located adjacent to the Angelina River where it crosses County Road 898 (see Figure 36 in the Appendix, page 177). The property is bounded on the north by the Angelina River, and Mud Creek meets the Angelina River on the west side. It is in Nacogdoches County, TX, and was sampled on October 30, 2017, by A. Camp and J. Grogan. The soil series in the area is a Mantachie soil, frequently flooded. This series has a taxonomic classification of fine-loamy, siliceous, acid, thermic

Aeric Fluvaquent. It is rated as a hydric soil. All sample points were in this soil series (see Figure 37 in the Appendix, page 178).

This site had areas with a National Wetlands Inventory rating of PFO1A and PFO1C, or palustrine, forested, broad-leaved deciduous wetlands that are flooded temporarily or seasonally. The area was almost entirely rated as PFO1A, with sloughs visible via aerial imagery that were rated as PFO1C. Plot 2 was rated as PFO1C, and the remaining plots were rated as PFO1A (see Figure 38 in the Appendix, page 179).

The site was clear-cut several days before sampling, so it was no longer forested.

Five sampling points were used in total. The sampling points ranged from approximately 175 – 475 m from the main channel of the Angelina River. Sampling point coordinates were as follows:

Table 6. Coordinates of the five sampling points assessed within Site 5, Sacul, TX.

| | Longitude | Latitude |
|---|---|---|
| Plot 1 | -94.97476555 | 31.79246333 |
| Plot 2 | -94.97585100 | 31.79313333 |
| Plot 3 | -94.97347556 | 31.79321655 |
| Plot 4 | -94.97472222 | 31.79333333 |
| Plot 5 | -94.97333333 | 31.79388889 |

## Determination

Two Atlantic and Gulf Coastal Plain wetland determination data forms were completed at each sampling location. All three wetland parameters were met for the points sampled at each location.

### Lake Naconiche Mitigation Area

Plot 1 at the Lake Naconiche Mitigation Area (Angelina County, TX) exhibited wetland hydrology through the following primary indicators: watermarks (B1), sediment deposits (B2), drift deposits (B3), water-stained leaves (B9), oxidized rhizospheres along living roots (C3); and the following secondary indicators: crayfish burrows (C8), saturation visible on aerial imagery (C9). At the time of sampling, no saturation, water table, or surface water were present. The watermarks on the site were very prominent. Light sediment deposits were visible about three feet high on tree trunks. Drift deposits were readily observable throughout the sampling location. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 1. Dominant species across all strata for the plot were *Quercus lyrata* (OBL), *Quercus nigra* (FAC), *Ulmus americana* (FAC), *Liquidambar styraciflua* (FAC), *Prunus serotina* (FACU), and *Quercus phellos* (FACW). The dominance test passed with a score of 89%, and morphological adaptations such as fluting and hypertrophied lenticels were observed. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 1 was measured at 2.5" thick. The A horizon was 8" thick, showed no signs of redox features, and had a sandy clay loam texture. It had a color of 5 YR 4/3 – reddish brown. The Bg1 horizon began at 8" deep and had a sandy clay loam texture. The start of the Bg2 horizon was not observed yet at 8" below the Bg1. The matrix color of the Bg1 horizon was 5 YR 5/1 – gray and accounted for 60% of the horizon. The redox features in the Bg1 horizon occurred as both soft iron-manganese masses and pore linings. They accounted for 40% of the horizon and were 5 YR 5/8 – yellowish red. This fulfilled the requirements of the depleted matrix (F3) hydric soil indicator because the matrix accounted for at least 60% of the soil horizon, the matrix had a value of 4 or greater and a chroma of 2 or less, and the horizon was at least 6" thick. Therefore, hydric soils were concluded to be present.

Plot 4 at the Lake Naconiche Mitigation Area (Angelina County, TX) exhibited wetland hydrology through the following primary indicators: watermarks (B1), drift deposits (B3), oxidized rhizospheres along living roots (C3); and the following secondary indicators: crayfish burrows (C8). At the time of sampling, no saturation, water table, or surface water were present. The watermarks on the site were very prominent. Drift deposits were readily observable throughout the sampling location. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 4. Dominant species across all strata for the plot were *Quercus phellos* (FACW), *Liquidambar styraciflua* (FAC), *Carpinus caroliniana* (FAC), *Ilex vomitoria* (FAC), and *Quercus lyrata* (OBL). The dominance test passed with a score of 100%, and morphological adaptations such as fluting and buttressing were observed. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 4 was measured at 2" thick. The A horizon was 10" thick, showed no signs of redox features, and had a sandy clay loam texture. It had a color of 7.5 YR 4/3 - brown. The Bg1 horizon began at 10" deep. The matrix (65%) had a color of 7.5 YR 5/2 - brown, and the redox features (35%) had a color of 7.5 YR 4/6 – strong brown. This fulfills the requirements of the depleted matrix (F3) hydric soil indicator, and hydric soils were concluded to be present.

The determination data collected is summarized in the table (see Table 7, page 53). Determination datasheets for this site are included in the Appendix (Figure 39a-Figure 40c, pages 180-185). Photos of the wetland hydrology, vegetation, and soil indicators observed on this site are located in the Appendix (Figure 41-Figure 43, page 186).

Table 7. Wetland determination parameters for Site 1, Lake Naconiche Mitigation Area.

| | Wetland Hydrology | Hydrophytic Vegetation | Hydric Soils |
|---|---|---|---|
| Plot 1 | Watermarks, sediment deposits, drift deposits, water-stained leaves, oxidized rhizospheres, crayfish burrows, saturation visible on aerial imagery | Dominance test 89% | (F3) Depleted Matrix |
| Plot 4 | Watermarks, drift deposits, oxidized rhizospheres, crayfish burrows | Dominance test 100% | (F3) Depleted Matrix |

Based on the determination results of the two selected sites, the homogeneity of the area, and NWI guidance the Lake Naconiche Mitigation Area was a wetland and is an appropriate site for functional assessment.

Stephen F. Austin Experimental Forest

Plot 1 at the Stephen F. Austin Experimental Forest (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: high water table (A2), saturation (A3), watermarks (B1), drift deposits (B3), water-stained leaves (B9), oxidized rhizospheres along living roots (C3); and the following secondary indicator: crayfish burrows (C8). At the time of sampling, saturation was present to the soil surface and the water table was present at 6.5 inches deep. Outside of the plot area was a small slough with several inches of standing water. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 1. Dominant species across all strata for the plot were *Quercus phellos* (FACW), *Liquidambar styraciflua* (FAC), and *Triadica sebifera* (FAC). The dominance test passed with a score of 100%. Fluting and buttressing were observed on most tree species, and a few exhibited surface roots as well. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 1 was measured at 2.0” thick. The A1g horizon was 6.5” thick, showed no signs of redox features, had a sandy clay loam texture, and had a color of 10 YR 4/2 – dark grayish brown. The C1g horizon began at 6.5” deep and had a clay loam texture. The matrix made up 75% of the horizon with a color of 10 YR 5/2 – grayish brown. The redox features made up 25% of the horizon and had a color of 5 YR 3/4 – dark reddish brown. The C1g horizon fulfilled the requirements of the depleted matrix (F3) hydric soil indicator because the matrix accounted for at least 60% of the soil horizon, the matrix had a value of 4 or greater and a chroma of 2 or less, and the horizon was at least 6” thick. Therefore, hydric soils were concluded to be present.

Plot 5 at the Stephen F. Austin Experimental Forest (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: high water table (A2), saturation (A3), watermarks (B1), drift deposits (B3), oxidized rhizospheres along living roots (C3); and the following secondary indicators: crayfish burrows (C8), saturation visible on aerial imagery (C9). At the time of sampling, saturation was present to the soil surface, and the water table was present at 8” deep. Drift deposits were very prominent in this plot and the soil pit was difficult to dig due to the presence of the water table. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 5. Dominant species across all strata for plot 5 were *Quercus nigra* (FAC), *Liquidambar styraciflua* (FAC), *Acer rubrum* (FAC), and *Triadica sebifera* (FAC). The dominance test passed with a score of 100%, and fluting and buttressing were observed on trees. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 5 was 1” thick. The A1g horizon was 10” thick and had a sandy clay loam texture. The matrix was 51% of the color 10 YR 4/1 – dark gray and the redox features were 49% of the color 2.5 YR 4/6 - red. The C1g horizon began at 10” deep and showed no mottling. It had the color 10 YR 6/1 – gray and was a clay loam texture. The C1g horizon fulfills the requirements of the depleted matrix (F3) hydric soil indicator because of its high value and low chroma, and hydric soils were concluded to be present.

The determination data collected is summarized in the table (see Table 8, page 56). Determination datasheets for this site are included in the Appendix (Figure 44a-Figure 45c, pages 187-192). Photos of the wetland hydrology, vegetation, and soil indicators observed on this site are located in the Appendix ( Figure 46-Figure 49, page 193).

Table 8. Wetland determination parameters for Site 2, Stephen F. Austin Experimental Forest.

| | Wetland Hydrology | Hydrophytic Vegetation | Hydric Soils |
|---|---|---|---|
| Plot 1 | High water table, saturation, watermarks, drift deposits, water-stained leaves, oxidized rhizospheres, crayfish burrows | Dominance test 100% | (F3) Depleted Matrix |
| Plot 5 | High water table, saturation, watermarks, drift deposits, oxidized rhizospheres, crayfish burrows, saturation visible on aerial imagery | Dominance test 100% | (F3) Depleted Matrix |

Based on the determination results of the two selected sites, the homogeneity of the area, and NWI guidance the sampled portion of the Stephen F. Austin Experimental Forest was a wetland and is an appropriate site for functional assessment.

Alazan Wildlife Management Area

Plot 1 in the Alazan Wildlife Management Area (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: saturation (A3), drift deposits (B3), water-stained leaves (B9), oxidized rhizospheres along living roots (C3); and the following secondary indicators: crayfish burrows (C8), saturation visible on aerial imagery (C9).  At the time of sampling, saturation was present within 5” of the soil surface, and the water table was present at 10” deep. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 1.  Dominant species across all strata for the site were *Quercus lyrata* (OBL), *Quercus nigra*

(FAC), *Ulmus Americana* (FAC), *Pinus taeda* (FAC), *Triadica sebifera* (FAC), and *Ampelopsis arborea* (FAC). The dominance test passed with a score of 100% and moderate fluting and buttressing were observed on trees. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 1 was measured at 2” thick. The A horizon began at the surface and the end was unable to be determined to due to the depth of the water table. It had a sandy clay loam texture. The matrix of this horizon was 60% 7.5 YR 4/2 – brown, and 40% 2.5 YR 4/6 – red. The A horizon fulfills the requirements of the depleted matrix (F3) hydric soil indicator because the matrix accounted for at least 60% of the soil horizon, the matrix had a value of 4 or greater and a chroma of 2 or less, and the horizon was at least 6” thick. Therefore, hydric soils were concluded to be present.

Plot 5 in the Alazan Wildlife Management Area (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: high water table (A2), saturation (A3), water marks (B1), drift deposits (B3), water-stained leaves (B9), oxidized rhizospheres along living roots (C3); and the following secondary indicators: crayfish burrows (C8), saturation visible on aerial imagery (C9). At the time of sampling, saturation was present to the soil surface, and the water table was present at 6” deep. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 5. Dominant species across all strata for the plot were *Quercus lyrata* (OBL), *Acer rubrum* (FAC), *Triadica sebifera* (FAC), *Nyssa sylvatica* (FAC), *Ilex vomitoria* (FAC), *Saururus cernuus* (OBL), and *Brunnichia ovata* (FACW). The dominance test passed with a score of 100%. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 5 was measured at 2” thick. The A horizon was 2” thick and had a loamy sand texture. It was 85% 7.5 YR 3/1 – very dark gray and 15% 2.5 YR 5/8 – red. The E horizon began at 2” and had a sandy clay loam texture. It was 60% 7.5 YR 4/1 – dark gray and 2.5 YR 4/8 – red. The E horizon fulfills the requirements of the depleted matrix (F3) hydric soil indicator, and hydric soils were concluded to be present.

The determination data collected is summarized in the table (see Table 9, page 59). Determination datasheets for this site are included in the Appendix (Figure 50a-51c, pages 194-199). Photos of the wetland hydrology, vegetation, and soil indicators observed on this site are located in the Appendix (Figure 52-Figure 54, page 200).

Table 9. Wetland determination parameters for Site 3, Alazan Wildlife Management Area.

| | Wetland Hydrology | Hydrophytic Vegetation | Hydric Soils |
|---|---|---|---|
| Plot 1 | Saturation, drift deposits, water-stained leaves, oxidized rhizospheres, crayfish burrows, saturation visible on aerial imagery | Dominance test 100% | (F3) Depleted Matrix |
| Plot 5 | High water table, saturation, water marks, drift deposits, water-stained leaves, oxidized rhizospheres, crayfish burrows, saturation visible on aerial imagery | Dominance test 100% | (F3) Depleted Matrix |

Based on the determination results of the two selected sites, the homogeneity of the area, and NWI guidance, the sampled portion of the Alazan Wildlife Management Area was a wetland and is an appropriate site for functional assessment.

Boggy Slough Conservation Area

Plot 1 at Boggy Slough Conservation Area (Trinity County, TX) exhibited wetland hydrology through the following primary indicators: water marks (B1), water-stained leaves (B9); and the following secondary indicator: crayfish burrows (C8). At the time of sampling, no saturation, water table, or surface water were present. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 1. Dominant species across all strata for the plot were *Quercus lyrata* (OBL), *Liquidambar* styraciflua (FAC), *Ilex opaca* (FAC), *Triadica sebifera* (FAC), and *Echinochloa* *crus-galli* (FACW). The dominance test passed with a score of 100%. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 1 was measured at 1” thick. The A horizon was 5” thick and had a silty clay loam texture. It was 50% 5 YR 5/1 – gray and 50% 2.5 YR 3/6 – dark red. The E horizon was 60% 10R 6/1 – reddish gray and 40 2.5 YR 3/6 – dark red. The E horizon fulfilled the requirements of the depleted matrix (F3) hydric soil indicator because the matrix accounted for at least 60% of the soil horizon, the matrix had a value of 4 or greater and a chroma of 2 or less, and the horizon was at least 6” thick. Therefore, hydric soils were concluded to be present.

Plot 5 at Boggy Slough Conservation Area (Trinity County, TX) exhibited wetland hydrology through the following primary indicators: water marks (B1), water-stained leaves (B9); and the following secondary indicator: crayfish burrows (C8). At the time of sampling, no saturation, water table, or surface water were present. Wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in plot 5. Dominant species across all strata for the plot were *Quercus phellos* (FACW), *Liquidambar styraciflua* (FAC), *Carya aquatica* (OBL), *Echinochloa crus-galli* (FACW), and *Eleocharis baldwinii* (OBL). The dominance test passed with a score of 100%. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 5 was measured at 1” thick. The A horizon was 6” thick and had a silty clay loam texture. It was 60% 5 YR 5/2 – reddish gray and 40% 2.5 YR 3/6 – dark red. The E horizon was 50% 7.5 YR 5/2 – brown and 50% 2.5 YR 4/8 – red. The A horizon fulfilled the requirements of the depleted matrix (F3) hydric soil indicator, and hydric soils were concluded to be present.

The determination data collected is summarized in the table below (see Table 10, page 61). Determination datasheets for this site are included in the Appendix (Figure 55a-Figure 56c, pages 201-206). Photos of the wetland hydrology, vegetation, and soil indicators observed on this site are located in the Appendix (Figure 57-Figure 58, page 207).

Table 10. Wetland determination parameters for Site 4, Boggy Slough Conservation Area.

| | Wetland Hydrology | Hydrophytic Vegetation | Hydric Soils |
|---|---|---|---|
| Plot 1 | Water marks, water-stained leaves, crayfish burrows | Dominance test 100% | (F3) Depleted Matrix |
| Plot 5 | Water marks, water-stained leaves, crayfish burrows | Dominance test 100% | (F3) Depleted Matrix |

Based on the determination results of the two selected sites, the homogeneity of the area, and NWI guidance, the sampled portion of the Boggy Slough Conservation Area was a wetland and is an appropriate site for functional assessment.

Sacul, TX

Plot 1 at the privately-owned tract of land near Sacul, TX (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: water marks (B1), oxidized rhizospheres along living roots (C3); and the following secondary indicator: saturation visible on aerial imagery (C9). This site was previously forested but was clear-cut harvested prior to sampling, but hydrology indicators were found. Therefore, wetland hydrology was concluded to be present.

Hydrophytic vegetation was also found to be present in Plot 1. Only two strata were present, herbaceous and woody vine. Dominant species across all strata for the plot were a *Carex* species (FAC), *Quercus lyrata* (OBL), *Arundinaria gigantea* (FACW), and *Rubus trivialis* (FACU). The dominance test passed with a score of 75%. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 1 was measured at 0.5” thick. The A horizon was 8” thick and had a sandy clay loam texture. It was 98% 5 YR 3/2 – dark reddish brown and 2% iron-manganese masses that were 10 R 2.5/1 – reddish black. The E horizon began at 8” and also had a sandy clay loam texture. It was 85% 5 YR 4/6 – yellowish red and 15% 5 YR 5/1 – gray. The A horizon fulfilled the requirements of the iron-manganese masses (F12) hydric soil indicator because the horizon was at least 4” thick, it was greater than 40% chroma 2 or less, and had 2% or more redox concentrations with a value and chroma of 3 or less. Therefore, hydric soils were concluded to be present.

Plot 5 at the privately-owned tract of land near Sacul, TX (Nacogdoches County, TX) exhibited wetland hydrology through the following primary indicators: water marks (B1), oxidized rhizospheres along living roots (C3); and the following secondary indicator: saturation visible on aerial imagery (C9). This site was previously forested and had been clear-cut harvested prior to sampling, but hydrology indicators were found to be present.

Hydrophytic vegetation was also found to be present in plot 5. The only strata present was herbaceous. Dominant species in this stratum were a *Carex* species (FAC) and *Carpinus caroliniana* (FAC). The dominance test passed with a score of 100%. Hydrophytic vegetation was concluded to be present.

The O horizon within plot 5 was measured at 0.25”. The A horizon was 3.5” deep and had a clay loam texture. It was 60% 5 YR 4/1 – dark gray and 40% 5 YR 4/6 – yellowish red. The E horizon began at 3.5” deep and had a clay loam texture. It was 90% 5 YR 4/6 – yellowish red and 10% 5 YR 5/1 – gray. The A horizon fulfilled the requirements of the depleted matrix (F3) hydric soil indicator because the matrix accounted for at least 60% of the soil horizon and had a value of 4 or greater and a chroma of 2 or less. Therefore, hydric soils were concluded to be present.

The determination data collected is summarized in the table below (see Table 11, page 64). Determination datasheets for this site are included in the Appendix (Figure 59a-Figure 60c, pages 208-213). Representative site photos are located in the Appendix (Figure 61-Figure 62, page 214).

Table 11. Wetland determination parameters for Site 5, Sacul, TX.

| | Wetland Hydrology | Hydrophytic Vegetation | Hydric Soils |
|---|---|---|---|
| Plot 1 | Water marks, oxidized rhizospheres, saturation visible on aerial imagery | Dominance test 75% | (F12) Iron-Manganese Masses |
| Plot 5 | Water marks, oxidized rhizospheres, saturation visible on aerial imagery | Dominance test 100% | (F3) Depleted Matrix |

Based on the determination results of the two selected sites, the homogeneity of the area, and NWI guidance, the sampled portion of the site near Sacul, TX, was a wetland and is an appropriate site for functional assessment.

## SEHGM

### Lake Naconiche Mitigation Area

Using the mid- or low-gradient riverine datasheets for the SEHGM assessment, the Lake Naconiche Mitigation area received an overall score of 0.98 for maintain characteristic hydrology, 0.90 for elemental transformation and cycling, 0.92 for maintain characteristic plant community, and 0.97 for provide characteristic wildlife habitat. These scores are displayed in Table 12 on page

65.  The plant community and wildlife habitat functions were used as the focus for analysis.

Table 12. SEHGM Functional Capacity Index (FCI) scores calculated for Site 1, Lake Naconiche Mitigation Area.

| SEHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Maintain Characteristic Hydrology | 0.98 |
| Elemental Transformation and Cycling | 0.90 |
| Maintain Characteristic Plant Community | 0.92 |
| Provide Characteristic Wildlife Habitat | 0.97 |

In calculating the FCI scores, the measured variables were assigned a subindex variable score.  Because the FCI scores were so high, it is obvious that the VSI scores would be high as well.  For example, $V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$, and $V_{BIG3}$ all scored a reference standard score of 1.00.  $V_{SOILINT}$ and $V_{CTDEN}$ also scored well, with 0.95 and 0.88, respectively.  However, $V_{WD}$ and $V_{COMP}$ were a bit lower than the rest, with scores of 0.54 and 0.75, respectively.  The site average VSI scores for each variable used in the function calculations are displayed in Table 13 on page 66.

Table 13. Average SEHGM Variable Subindex (VSI) scores for Site 1, Lake Naconiche Mitigation Area.

| SEHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{CONNECT}$ – Percent of wetland perimeter connected to suitable habitat | 1.00 |
| $V_{SOILINT}$ – Soil integrity | 0.95 |
| $V_{HYDROSYS}$ – Hydrologic alteration of system | 1.00 |
| $V_{HYDROALT}$ – hydrologic alteration of site | 1.00 |
| $V_{BIG3}$ – Average DBH of the three largest canopy trees per plot | 1.00 |
| $V_{CTDEN}$ – Average number of canopy trees per hectare | 0.88 |
| $V_{WD}$ – Large woody debris biomass | 0.54 |
| $V_{COMP}$ – Vegetation composition score | 0.75 |

$V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{SOILINT}$ is also a site-level variable, and it received a score of 0.95 across all plots. $V_{BIG3}$, a plot-level variable, also received a score of 1.00 at all five sampling plots.

While the average SEHGM VSI scores were relatively high for this site, a range of scores can be observed among the plot-level variables. Plot 1 had a $V_{CTDEN}$ score of only 0.38, while the other plots all received a 1.00. This brought the site average for tree density down to 0.88. $V_{WD}$ received plot VSI scores ranging from 0.00 – 1.00. Plots 1 and 2 received near reference standard VSI scores for $V_{WD}$ (1.00 and 0.96, respectively), but plots 3-5 received VSI scores ranging from 0.00 to 0.51. Plots 1, 4, and 5 all scored over 0.82 for $V_{COMP}$, but plots 2 and 3 only received a score of 0.50. Individual VSI scores for all variables in all five plots are located in Table 43 in the Appendix, page 215.

The range in scores, particularly in $V_{CTDEN}$, $V_{WD}$, and $V_{COMP}$, demonstrate the importance of measuring multiple plots in order to calculate a site average. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.90.

<u>Stephen F. Austin Experimental Forest</u>

Using the mid- or low-gradient riverine datasheets for the SEHGM assessment, the Stephen F. Austin Experimental Forest received an overall score of 0.99 for maintain characteristic hydrology, 0.95 for elemental transformation and cycling, 0.92 for maintain characteristic plant community, and 0.97 for provide characteristic wildlife habitat. These scores are displayed in Table 14 below, page 67. The plant community and wildlife habitat functions were used as the focus for analysis.

Table 14. SEHGM Functional Capacity Index (FCI) scores calculated for Site 2, Stephen F. Austin Experimental Forest.

| SEHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Maintain Characteristic Hydrology | 0.99 |
| Elemental Transformation and Cycling | 0.95 |
| Maintain Characteristic Plant Community | 0.92 |
| Provide Characteristic Wildlife Habitat | 0.97 |

In calculating the FCI scores, the measured variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$, and $V_{BIG3}$ all scored a reference standard score of 1.00. $V_{SOILINT}$ and $V_{CTDEN}$ also scored very high, with 0.95 and 0.93, respectively. $V_{WD}$ and $V_{COMP}$ were the variables with the lowest scores, but they still scored well with 0.82 and 0.74, respectively. The site average VSI scores for each variable used in the function calculations are displayed in Table 15 below, page 68.

Table 15. Average SEHGM Variable Subindex (VSI) scores for Site 2, Stephen F. Austin Experimental Forest.

| SEHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{CONNECT}$ – Percent of wetland perimeter connected to suitable habitat | 1.00 |
| $V_{SOILINT}$ – Soil integrity | 0.95 |
| $V_{HYDROSYS}$ – Hydrologic alteration of system | 1.00 |
| $V_{HYDROALT}$ – hydrologic alteration of site | 1.00 |
| $V_{BIG3}$ – Average DBH of the three largest canopy trees per plot | 1.00 |
| $V_{CTDEN}$ – Average number of canopy trees per hectare | 0.93 |
| $V_{WD}$ – Large woody debris biomass | 0.82 |
| $V_{COMP}$ – Vegetation composition score | 0.74 |

$V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{SOILINT}$ is also a site-level variable, and it received a score of 0.95 across all plots. $V_{BIG3}$, a plot-level variable, also received a score of 1.00 at all five sampling plots.

$V_{CTDEN}$ remained moderately consistent across all plots, scoring 0.88, 1.00, 0.88, 1.00, and 0.88. $V_{COMP}$ was consistent as well, scoring 0.71, 0.71, 0.87, 0.71, and 0.71. $V_{WD}$ exhibited the greatest variation among plots, ranging from 0.49-1.00.

Individual VSI scores for all variables in all five plots are located in Table 44 in the Appendix, page 215. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.92.

<u>Alazan Wildlife Management Area</u>

Using the mid- or low-gradient riverine datasheets for the SEHGM assessment, the Alazan Wildlife Management Area received an overall score of 0.99 for maintain characteristic hydrology, 0.87 for elemental transformation and cycling, 0.92 for maintain characteristic plant community, and 0.97 for provide characteristic wildlife habitat. These scores are displayed in Table 16 below, page 69. The plant community and wildlife habitat functions were used as the focus for analysis.

Table 16. SEHGM Functional Capacity Index (FCI) scores calculated for Site 3, Alazan Wildlife Management Area.

| SEHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Maintain Characteristic Hydrology | 0.99 |
| Elemental Transformation and Cycling | 0.87 |
| Maintain Characteristic Plant Community | 0.92 |
| Provide Characteristic Wildlife Habitat | 0.97 |

In calculating the FCI scores, the measured variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$, and $V_{BIG3}$ all scored a reference standard score of 1.00. $V_{SOILINT}$ and $V_{CTDEN}$ also scored well, with 0.95 for each. However, $V_{COMP}$ was a bit lower than the rest, with a score of 0.70, and $V_{WD}$ was much lower with a score of 0.32. The site average VSI scores for each variable used in the function calculations are displayed in Table 17 below, page 70.

Table 17. Average SEHGM Variable Subindex (VSI) scores for Site 3, Alazan Wildlife Management Area.

| SEHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{CONNECT}$ – Percent of wetland perimeter connected to suitable habitat | 1.00 |
| $V_{SOILINT}$ – Soil integrity | 0.95 |
| $V_{HYDROSYS}$ – Hydrologic alteration of system | 1.00 |
| $V_{HYDROALT}$ – hydrologic alteration of site | 1.00 |
| $V_{BIG3}$ – Average DBH of the three largest canopy trees per plot | 1.00 |
| $V_{CTDEN}$ – Average number of canopy trees per hectare | 0.95 |
| $V_{WD}$ – Large woody debris biomass | 0.32 |
| $V_{COMP}$ – Vegetation composition score | 0.70 |

$V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{SOILINT}$ is also a site-level variable, and it received a score of 0.95 across all plots. $V_{BIG3}$, a plot-level variable, also received a score of 1.00 at all five sampling plots.

$V_{CTDEN}$ scored high consistently across all plots, scoring 1.00, 1.00, 0.88, 0.88, and 1.00. $V_{COMP}$ scored lower, but was still somewhat consistent from plot to plot, with 0.71, 0.71, 0.87, 0.50, and 0.71. $V_{WD}$ was the lowest scoring variable, with scores ranging from 0.00-0.50. Individual VSI scores for all variables in all five plots are located in Table 45 in the Appendix, page 217.

The range in scores, particularly in $V_{WD}$, demonstrates the importance of measuring multiple plots in order to calculate a site average. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.87.

<u>Boggy Slough Conservation Area</u>

Using the mid- or low-gradient riverine datasheets for the SEHGM assessment, the Boggy Slough Conservation Area received an overall score of 0.97 for maintain characteristic hydrology, 0.86 for elemental transformation and cycling, 0.91 for maintain characteristic plant community, and 0.96 for provide characteristic wildlife habitat. These scores are displayed in Table 18, page 72. The plant community and wildlife habitat functions were used as the focus for analysis.

Table 18. SEHGM Functional Capacity Index (FCI) scores calculated for Site 4, Boggy Slough Conservation Area.

| SEHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Maintain Characteristic Hydrology | 0.97 |
| Elemental Transformation and Cycling | 0.86 |
| Maintain Characteristic Plant Community | 0.91 |
| Provide Characteristic Wildlife Habitat | 0.96 |

In calculating the FCI scores, the measured variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$, and $V_{BIG3}$ all scored a reference standard score of 1.00. $V_{SOILINT}$ and $V_{CTDEN}$ also scored well, with 0.95 and 0.80, respectively. However, $V_{WD}$ and $V_{COMP}$ were a bit lower than the rest, with scores of 0.36 and 0.77, respectively. The site average VSI scores for each variable used in the function calculations are displayed in Table 19 below, page 72.

Table 19. Average SEHGM Variable Subindex (VSI) scores for Site 4, Boggy Slough Conservation Area.

| SEHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{CONNECT}$ – Percent of wetland perimeter connected to suitable habitat | 1.00 |
| $V_{SOILINT}$ – Soil integrity | 0.95 |
| $V_{HYDROSYS}$ – Hydrologic alteration of system | 1.00 |
| $V_{HYDROALT}$ – hydrologic alteration of site | 1.00 |
| $V_{BIG3}$ – Average DBH of the three largest canopy trees per plot | 1.00 |
| $V_{CTDEN}$ – Average number of canopy trees per hectare | 0.80 |
| $V_{WD}$ – Large woody debris biomass | 0.36 |
| $V_{COMP}$ – Vegetation composition score | 0.77 |

$V_{CONNECT}$, $V_{HYDROSYS}$, $V_{HYDROALT}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{SOILINT}$ is also a site-level variable, and it received a score of 0.95 across all plots. $V_{BIG3}$, a plot-level variable, also received a score of 1.00 at all five sampling plots.

While the average SEHGM VSI scores were relatively high for this site, a range of scores can be observed among the plot-level variables. $V_{CTDEN}$ ranged from plot to plot, with scores of 0.63, 1.00, 1.00, 0.63, and 0.75. $V_{COMP}$ was more consistent, scoring either 0.71 or 0.87 at each plot. $V_{WD}$ showed the greatest variation, with scores ranging from 0.00-0.83. Individual VSI scores for all variables in all five plots are located in Table 46 in the Appendix, page 218.

The range in scores, particularly in $V_{CTDEN}$ and $V_{WD}$, demonstrate the importance of measuring multiple plots in order to calculate a site average. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.86.

Sacul, TX

Using the mid- or low-gradient riverine datasheets for the SEHGM assessment, the site near Sacul, TX, received an overall score of 0.71 for maintain characteristic hydrology, 0.70 for elemental transformation and cycling, 0.20 for maintain characteristic plant community, and 0.72 for provide characteristic wildlife habitat. These scores are displayed in Table 20 below, page 74. The plant community and wildlife habitat functions were used as the focus for analysis.

Table 20. SEHGM Functional Capacity Index (FCI) scores calculated for Site 5, Sacul, TX.

| SEHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Maintain Characteristic Hydrology | 0.71 |
| Elemental Transformation and Cycling | 0.70 |
| Maintain Characteristic Plant Community | 0.20 |
| Provide Characteristic Wildlife Habitat | 0.72 |

In calculating the FCI scores, the measured variables were assigned a subindex variable score. Even though this site had been recently clear-cut, it exhibited a score of about 0.70 for 3 of the 4 calculated functions. The site-level variables $V_{CONNECT}$, $V_{HYDROSYS}$, and $V_{HYDROALT}$ all scored a reference standard of 1.00. $V_{SOILINT}$ was high as well, with a 0.95. $V_{WD}$ scored a 0.51, $V_{COMP}$ scored a 0.39, and $V_{GVC}$ was the lowest with a score of 0.02. The site average VSI scores for each variable used in the function calculations are displayed in Table 21 on page 75.

Table 21. Average Variable Subindex (VSI) scores for Site 5, Sacul, TX.

| SEHGM Variable | Average Variable Subindex Score (VSI) |
| --- | --- |
| $V_{CONNECT}$ – Percent of wetland perimeter connected to suitable habitat | 1.00 |
| $V_{SOILINT}$ – Soil integrity | 0.95 |
| $V_{HYDROSYS}$ – Hydrologic alteration of system | 1.00 |
| $V_{HYDROALT}$ – Hydrologic alteration of site | 1.00 |
| $V_{GVC}$ – Average percent cover of ground-layer vegetation | 0.02 |
| $V_{WD}$ – Large woody debris biomass | 0.51 |
| $V_{COMP}$ – Vegetation composition score | 0.39 |

## ETXHGM

Lake Naconiche Mitigation Area

Using the low-gradient riverine datasheets for the ETXHGM assessment, the Lake Naconiche Mitigation area received an overall score of 1.00 for detain floodwater, 1.00 for detain precipitation, 1.00 for cycle nutrients, 1.00 for export organic carbon, 0.90 for maintain plant communities, and 0.96 for provide habitat for fish and wildlife. These scores are displayed in Table 22 on page 76. The maintain plant communities and provide habitat for fish and wildlife functions were used as the focus of analysis.

Table 22. ETXHGM Functional Capacity Index (FCI) scores calculated for Site 1, Lake Naconiche Mitigation Area.

| ETXHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Detain Floodwater | 1.00 |
| Detain Precipitation | 1.00 |
| Cycle Nutrients | 1.00 |
| Export Organic Carbon | 1.00 |
| Maintain Plant Communities | 0.90 |
| Provide Habitat for Fish & Wildlife | 0.96 |

In calculating the FCI scores, the variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{SSD}$, $V_{GVC}$, $V_{LITTER}$, $V_{LOG}$, and $V_{WD}$ all scored a reference standard VSI score of 1.00. $V_{STRATA}$ and $V_{SOIL}$ also scored well, with scores of 0.80 and 0.95, respectively. $V_{TCOMP}$ was by far the lowest scored variable for this site, receiving a score of only 0.66. The site average VSI scores for each variable used in the function calculations are displayed in Table 23 on page 77.

Table 23. Average ETXHGM Variable Subindex (VSI) scores for Site 1, Lake Naconiche Mitigation Area.

| ETXHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{PATCH}$ – Forested patch size | 1.00 |
| $V_{FREQ}$ – Change in frequency of flooding | 1.00 |
| $V_{DUR}$ – Change in growing season flood duration | 1.00 |
| $V_{POND}$ – Total ponded area | 1.00 |
| $V_{STRATA}$ – Number of vegetation strata | 0.80 |
| $V_{SOIL}$ – Soil integrity | 0.95 |
| $V_{TBA}$ – Tree basal area | 1.00 |
| $V_{TDEN}$ – Tree density | 1.00 |
| $V_{SNAG}$ – Snag density | 1.00 |
| $V_{OHOR}$ – O horizon organic accumulation | 1.00 |
| $V_{AHOR}$ – A horizon organic accumulation | 1.00 |
| $V_{TCOMP}$ – Tree composition | 0.66 |
| $V_{SSD}$ – Shrub-sapling density | 1.00 |
| $V_{GVC}$ – Ground vegetation cover | 1.00 |
| $V_{LITTER}$ – Litter cover | 1.00 |
| $V_{LOG}$ – Log biomass | 1.00 |
| $V_{WD}$ – Woody debris biomass | 1.00 |

$V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, and $V_{POND}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{STRATA}$ and $V_{SOIL}$ are also site-level variables and received scores of 0.80 and 0.95 across the site, respectively. Most variables for this assessment scored a 1.00. The plot-level variables $V_{TDEN}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, and $V_{LITTER}$ all received a score of 1.00 across all plots.

$V_{TBA}$ received a score of 0.64 at plot 1, but plots 2-5 received a score of 1.00, so the average measure still received a score of 1.00. $V_{SNAG}$ received a score of 0.00 at plot 1, but plots 2-5 received a score of 1.00, so the average measure still received a score of 1.00. $V_{TCOMP}$ scored from 0.73-0.58 across plots, resulting in the average measure VSI of 0.66. $V_{SSD}$ scored well in plots 3-5 (1.00, 0.95, and 1.00, respectively), but scored 0.42 and 0.00, respectively, in plots 1 and 2. Once again, the average measure was still high enough to score a VSI of 1.00. $V_{LOG}$ received a score of 1.00 in plots 1 and 3. It then received a score of 0.58, 0.54, and 0.00 in plots 2, 4, and 5, respectively, and the average measure received a VSI of 1.00. $V_{WD}$ received a score of 1.00 in plots 1, 3, 4, and 5, and a 0.50 in plot 2. It also received an average measure VSI of 1.00.

Individual VSI scores for all variables in all five plots are located in Table 48 in the Appendix, page 220. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.90.

Stephen F. Austin Experimental Forest

Using the low-gradient riverine datasheets for the ETXHGM assessment, the Stephen F. Austin Experimental Forest area received an overall score of 0.93 for detain floodwater, 1.00 for detain precipitation, 0.92 for cycle nutrients, 0.92 for export organic carbon, 0.93 for maintain plant communities, and 0.98 for provide habitat for fish and wildlife. These scores are displayed in Table 24 on page 79. The maintain plant communities and provide habitat for fish and wildlife functions were used as the focus of analysis.

Table 24. ETXHGM Functional Capacity Index (FCI) scores calculated for Site 2, Stephen F. Austin Experimental Forest.

| ETXHGM Function | Functional Capacity Index (FCI) |
| --- | --- |
| Detain Floodwater | 0.93 |
| Detain Precipitation | 1.00 |
| Cycle Nutrients | 0.92 |
| Export Organic Carbon | 0.92 |
| Maintain Plant Communities | 0.93 |
| Provide Habitat for Fish & Wildlife | 0.98 |

In calculating the FCI scores, the variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, $V_{STRATA}$, $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, $V_{LITTER}$, and $V_{LOG}$ all scored a reference standard VSI score of 1.00. $V_{SOIL}$ also scored well with a score of 0.95.

$V_{TCOMP}$, $V_{SSD}$, $V_{WD}$ were the lowest scoring variables, with scores of 0.76, 0.73, and 0.75, respectively.

The site average VSI scores for each variable used in the function calculations are displayed in Table 25 on page 80.

Table 25. Average ETXHGM Variable Subindex (VSI) scores for Site 2, Stephen F. Austin Experimental Forest.

| ETXHGM Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{PATCH}$ – Forested patch size | 1.00 |
| $V_{FREQ}$ – Change in frequency of flooding | 1.00 |
| $V_{DUR}$ – Change in growing season flood duration | 1.00 |
| $V_{POND}$ – Total ponded area | 1.00 |
| $V_{STRATA}$ – Number of vegetation strata | 1.00 |
| $V_{SOIL}$ – Soil integrity | 0.95 |
| $V_{TBA}$ – Tree basal area | 1.00 |
| $V_{TDEN}$ – Tree density | 1.00 |
| $V_{SNAG}$ – Snag density | 1.00 |
| $V_{OHOR}$ – O horizon organic accumulation | 1.00 |
| $V_{AHOR}$ – A horizon organic accumulation | 1.00 |
| $V_{TCOMP}$ – Tree composition | 0.76 |
| $V_{SSD}$ – Shrub-sapling density | 0.73 |
| $V_{GVC}$ – Ground vegetation cover | 1.00 |
| $V_{LITTER}$ – Litter cover | 1.00 |
| $V_{LOG}$ – Log biomass | 1.00 |
| $V_{WD}$ – Woody debris biomass | 0.75 |

$V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, and $V_{STRATA}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{SOIL}$ is also a site-level variable and received a score of 0.95 across the site. Most variables for this assessment scored a 1.00. The plot-level variables $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, $V_{LITTER}$, and $V_{LOG}$ all received a score of 1.00 across all plots.

$V_{TCOMP}$ scored from 0.66-0.83 across plots, resulting in the average measure VSI of 0.76. $V_{SSD}$ scored well in plots 3 and 5 (1.00 and 0.93, respectively), but scored 0.21, 0.52, and 0.10, respectively, in plots 1, 2, and 4. However, the average measure was still high enough to score a VSI of 0.73. $V_{WD}$ received a score of 1.00 in plots 1 and 3; a 0.91 in plot 2; and a 0.51 and 0.50 in plots 4 and 5. It still received an average measure VSI of 0.75.

Individual VSI scores for all variables in all five plots are located in Table 49 in the Appendix, page 221. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.92.

<u>Alazan Wildlife Management Area</u>

Using the low-gradient riverine datasheets for the ETXHGM assessment, the Alazan Wildlife Management Area received an overall score of 0.88 for detain floodwater, 1.00 for detain precipitation, 0.87 for cycle nutrients, 0.87 for export organic carbon, 0.95 for maintain plant communities, and 0.97 for provide habitat for fish and wildlife. These scores are displayed in Table 26 below, page 81. The maintain plant communities and provide habitat for fish and wildlife functions were used as the focus of analysis.

Table 26. ETXHGM Functional Capacity Index (FCI) scores calculated for Site 3, Alazan Wildlife Management Area.

| ETXHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Detain Floodwater | 0.88 |
| Detain Precipitation | 1.00 |
| Cycle Nutrients | 0.87 |
| Export Organic Carbon | 0.87 |
| Maintain Plant Communities | 0.95 |
| Provide Habitat for Fish & Wildlife | 0.97 |

In calculating the FCI scores, the variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, and $V_{LITTER}$ all scored a reference standard VSI score of 1.00. $V_{STRATA}$, $V_{SOIL}$, $V_{TCOMP}$, and $V_{LOG}$ also scored well, with scores of 0.80, 0.95, 0.83, and 0.95, respectively. $V_{SSD}$ and $V_{WD}$ were the lowest scoring variables, with scores of 0.58 and 0.52, respectively. The site average VSI scores for each variable used in the function calculations are displayed in Table 27 below, page 82.

Table 27. Average ETXHGM Variable Subindex (VSI) scores for Site 3, Alazan Wildlife Management Area.

| Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{PATCH}$ – Forested patch size | 1.00 |
| $V_{FREQ}$ – Change in frequency of flooding | 1.00 |
| $V_{DUR}$ – Change in growing season flood duration | 1.00 |
| $V_{POND}$ – Total ponded area | 1.00 |
| $V_{STRATA}$ – Number of vegetation strata | 0.80 |
| $V_{SOIL}$ – Soil integrity | 0.95 |
| $V_{TBA}$ – Tree basal area | 1.00 |
| $V_{TDEN}$ – Tree density | 1.00 |
| $V_{SNAG}$ – Snag density | 1.00 |
| $V_{OHOR}$ – O horizon organic accumulation | 1.00 |
| $V_{AHOR}$ – A horizon organic accumulation | 1.00 |
| $V_{TCOMP}$ – Tree composition | 0.83 |
| $V_{SSD}$ – Shrub-sapling density | 0.58 |
| $V_{GVC}$ – Ground vegetation cover | 1.00 |
| $V_{LITTER}$ – Litter cover | 1.00 |
| $V_{LOG}$ – Log biomass | 0.95 |
| $V_{WD}$ – Woody debris biomass | 0.52 |

$V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, and $V_{POND}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{STRATA}$ and $V_{SOIL}$ are also site-level variables and received scores of 0.80 and 0.95 across the site, respectively. Most variables for this assessment scored a 1.00. The plot-level variables $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, and $V_{LITTER}$ all received a score of 1.00 across all plots.

$V_{SNAG}$ received a score of 0.00 at plot 1, but plots 2-5 received a score of 1.00, so the average measure still received a score of 1.00. $V_{TCOMP}$ scored from 0.66-1.00 across plots, resulting in the average measure VSI of 0.83. $V_{SSD}$ scored well in plot 5 (0.83) but scored between 0.31-0.58 in plots 1-4. The average measure scored a VSI of 0.58. $V_{WD}$ received a high score in plots 2 and 3 (1.00 and 0.96, respectively), but scores much lower in plots 1, 4, and 5 (0.50, 0.50, 0.58, respectively). It received an average measure VSI of 0.52.

Individual VSI scores for all variables in all five plots are located in Table 50 in the Appendix, page 222. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.87.

Boggy Slough Conservation Area

Using the low-gradient riverine datasheets for the ETXHGM assessment, Boggy Slough Conservation Area received an overall score of 0.86 for detain floodwater, 1.00 for detain precipitation, 0.88 for cycle nutrients, 0.88 for export organic carbon, 0.96 for maintain plant communities, and 0.98 for provide habitat for fish and wildlife. These scores are displayed in Table 28 below, page 84. The maintain plant communities and provide habitat for fish and wildlife functions were used as the focus of analysis.

Table 28. ETXHGM Functional Capacity Index (FCI) scores calculated for Site 4, Boggy Slough Conservation Area.

| ETXHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Detain Floodwater | 0.86 |
| Detain Precipitation | 1.00 |
| Cycle Nutrients | 0.88 |
| Export Organic Carbon | 0.88 |
| Maintain Plant Communities | 0.96 |
| Provide Habitat for Fish & Wildlife | 0.98 |

In calculating the FCI scores, the variables were assigned a subindex variable score. Because the FCI scores were so high, it is obvious that the VSI scores would be high as well. For example, $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, $V_{POND}$, $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{SSD}$, $V_{GVC}$, $V_{LITTER}$, and $V_{LOG}$ all scored a reference standard VSI score of 1.00. $V_{STRATA}$, $V_{SOIL}$, $V_{TCOMP}$, and $V_{WD}$ also scored well, with scores of 0.80, 0.95, 0.88, and 0.79, respectively. $V_{SSD}$ was by far the lowest scored variable for this site, receiving a score of only 0.44. The site average VSI scores for each variable used in the function calculations are displayed in Table 29 on page 85.

Table 29. Average ETXHGM Variable Subindex (VSI) scores for Site 4, Boggy Slough Conservation Area.

| Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{PATCH}$ – Forested patch size | 1.00 |
| $V_{FREQ}$ – Change in frequency of flooding | 1.00 |
| $V_{DUR}$ – Change in growing season flood duration | 1.00 |
| $V_{POND}$ – Total ponded area | 1.00 |
| $V_{STRATA}$ – Number of vegetation strata | 0.80 |
| $V_{SOIL}$ – Soil integrity | 0.95 |
| $V_{TBA}$ – Tree basal area | 1.00 |
| $V_{TDEN}$ – Tree density | 1.00 |
| $V_{SNAG}$ – Snag density | 1.00 |
| $V_{OHOR}$ – O horizon organic accumulation | 1.00 |
| $V_{AHOR}$ – A horizon organic accumulation | 1.00 |
| $V_{TCOMP}$ – Tree composition | 0.88 |
| $V_{SSD}$ – Shrub-sapling density | 0.44 |
| $V_{GVC}$ – Ground vegetation cover | 1.00 |
| $V_{LITTER}$ – Litter cover | 1.00 |
| $V_{LOG}$ – Log biomass | 1.00 |
| $V_{WD}$ – Woody debris biomass | 0.79 |

$V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, and $V_{POND}$ are site-level variables, and therefore received the same score across all plots. For this site, those variables scored a 1.00. $V_{STRATA}$ and $V_{SOIL}$ are also site-level variables and received scores of 0.80 and 0.95 across the site, respectively. Most variables for this assessment scored a 1.00. The plot-level variables $V_{TBA}$, $V_{TDEN}$, $V_{SNAG}$, $V_{OHOR}$, $V_{AHOR}$, $V_{GVC}$, $V_{LITTER}$, and $V_{LOG}$ all received a score of 1.00 across all plots.

$V_{SNAG}$ received a score of 1.00 at plots 1, 2, and 4, and a score of 0.60 and 0.00 and plots 3 and 5, respectively. It still received an average measure score of 1.00. $V_{TCOMP}$ scored from 0.66-1.00 across plots, resulting in the average measure VSI of 0.88. $V_{SSD}$ varied greatly from plot to plot, scoring 0.00-0.73 across all plots, resulting in an average VSI of 0.44. $V_{LOG}$ scored well in plots 2 and 3, with scores of 1.00 and 0.94, respectively, but scored between 0.00-0.50 in plots 1, 4, and 5. However, the average VSI measure was still high enough to score 1.00. $V_{WD}$ received a score of 1.00 in plots 3 and 5, and 0.50-0.73 in plots 1, 2, and 4. It also received an average measure VSI of 1.00.

Individual VSI scores for all variables in all five plots are located in Table 51 in the Appendix, page 223. Overall, this site scored nearly as well as a reference standard site, since the lowest calculated function was 0.86.

Sacul, TX

Using the low-gradient riverine datasheets for the ETXHGM assessment, the site near Sacul, TX, received an overall score of 0.52 for detain floodwater, 0.78 for detain precipitation, 0.51 for cycle nutrients, 0.46 for export organic carbon, 0.59 for maintain plant communities, and 0.65 for provide habitat for fish and wildlife. These scores are displayed in Table 30 on page 87. The maintain plant communities and provide habitat for fish and wildlife functions were used as the focus of analysis.

Table 30. ETXHGM Functional Capacity Index (FCI) scores calculated for Site 5, Sacul, TX.

| ETXHGM Function | Functional Capacity Index (FCI) |
|---|---|
| Detain Floodwater | 0.52 |
| Detain Precipitation | 0.78 |
| Cycle Nutrients | 0.51 |
| Export Organic Carbon | 0.46 |
| Maintain Plant Communities | 0.59 |
| Provide Habitat for Fish & Wildlife | 0.65 |

In calculating the FCI scores, the variables were assigned a subindex variable score. Although the FCI scores were much lower for this site than the other 4 (as expected), some variables still scored highly on their own. For example, the site-level variables $V_{PATCH}$, $V_{FREQ}$, $V_{DUR}$, and $V_{POND}$, all scored a reference standard VSI score of 1.00. The site-level variables $V_{AHOR}$,$V_{GVC}$, and $V_{LOG}$ also scored a reference standard VSI score of 1.00. $V_{COMP}$, $V_{LITTER}$, and $V_{WD}$ were a bit lower, scoring 0.68, 0.65, and 0.61, respectively. $V_{SNAG}$ received a score of 0.50 and $V_{OHOR}$ received a score of 0.49. $V_{STRATA}$ received a score of 0.40, since only one vegetative strata was present across the site. $V_{TBA}$, $V_{SSD}$, and $V_{TDEN}$ scored the lowest for this site, with 0.05, 0.04, and 0.03, respectively. The site average VSI scores for each variable used in the function calculations are displayed in Table 31 on page 88.

Table 31. Average ETXHGM Variable Subindex (VSI) scores for Site 5, Sacul, TX.

| Variable | Average Variable Subindex Score (VSI) |
|---|---|
| $V_{PATCH}$ – Forested patch size | 1.00 |
| $V_{FREQ}$ – Change in frequency of flooding | 1.00 |
| $V_{DUR}$ – Change in growing season flood duration | 1.00 |
| $V_{POND}$ – Total ponded area | 1.00 |
| $V_{STRATA}$ – Number of vegetation strata | 0.40 |
| $V_{SOIL}$ – Soil integrity | 0.95 |
| $V_{TBA}$ – Tree basal area | 0.05 |
| $V_{TDEN}$ – Tree density | 0.03 |
| $V_{SNAG}$ – Snag density | 0.50 |
| $V_{OHOR}$ – O horizon organic accumulation | 0.49 |
| $V_{AHOR}$ – A horizon organic accumulation | 1.00 |
| $V_{COMP}$ – Tallest stratum composition | 0.68 |
| $V_{SSD}$ – Shrub-sapling density | 0.04 |
| $V_{GVC}$ – Ground vegetation cover | 1.00 |
| $V_{LITTER}$ – Litter cover | 0.65 |
| $V_{LOG}$ – Log biomass | 1.00 |
| $V_{WD}$ – Woody debris biomass | 0.61 |

$V_{TBA}$ scored 0.00-0.13 at each plot, resulting in an average VSI of 0.05. $V_{TDEN}$ scored 0.00-0.13 at each plot, resulting in an average VSI of 0.03. $V_{SNAG}$ scored 0.00, 1.00, 0.00, 0.00, and 1.00, respectively. It scored an average VSI of 0.50. $V_{OHOR}$ received scores ranging from 0.20-1.00 at each plot, resulting in an average VSI of 0.49. $V_{COMP}$ received scores of 0.50, 0.55, 1.00, 0.78, and 0.55, respectively, with an average VSI of 0.68. $V_{SSD}$ scored 0.00 in plots 1, 3, 4, and 5, and scores 0.21 in plot 2. This resulted in an average VSI of 0.04. $V_{LITTER}$ varied widely across plots, scoring 1.00, 0.50, 0.66, 0.50, and 0.63, respectively. It scored an average VSI of 0.65. $V_{WD}$ scored 0.50, 0.50, 1.00, 1.00, and 0.97 at each plot, with an average VSI of 0.61.

Individual VSI scores for all variables in all five plots are located in Table 52 in the Appendix, page 224. Overall, this site scored higher than expected, with FCI scores ranging from 0.46-0.78.

## TXRAM

Lake Naconiche Mitigation Area

Using the TXRAM wetlands module assessment, the Lake Naconiche Mitigation area received an overall score of 91.46. A summary of the scores found at each plot for each core element is located below in Table 32, page 89. The site average was used for analysis.

Table 32. TXRAM scores for Site 1, Lake Naconiche Mitigation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Landscape | 13.88 | 13.88 | 13.88 | 13.88 | 13.88 | 13.88 |
| Hydrology | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Soils | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| Physical Structure | 18.33 | 18.33 | 18.33 | 18.33 | 18.33 | 18.33 |
| Biotic Structure | 18.57 | 17.86 | 17.86 | 17.86 | 17.86 | 18.00 |
| Total | 92.03 | 91.32 | 91.32 | 91.32 | 91.32 | 91.46 |

The landscape core element has a total of 15 points possible, hydrology has 30 possible points, soils has 15 possible points, physical structure has 20 possible points, and biotic structure has 20 possible points. This gives a total of 100 possible points. Each core element is made up of individual metrics. Each individual metric is worth a possible 4 points. The metrics that make up each core element are summed, divided by the total possible points from the metrics, and then multiplied by the number of points possible for that core element. For example, the landscape core element consists of the aquatic context and buffer metrics. Site 1 scored a 4/4 on aquatic context and 3.4/4 on buffer. The scores of the two individual metrics are summed, divided by 8 (the total points possible), and then multiplied by 15 (the weight of the core element). This resulted in a landscape core element score of 13.88/15.

Since TXRAM is not evaluated in a specific plot size, like HGM, many of the metrics were the same across all plots, similar to HGM's site-level variables. Variation was mainly seen among plots on the species richness and non-native/invasive infestation metrics.

The hydrology core element consists of the water source, hydroperiod, and hydrologic flow metrics. Site 1 scored a 4/4 for all of these metrics. This resulted in a hydrology core element score of 30/30.

The soils core element consists of the organic matter, sedimentation, and soil modification metrics. Site 1 scored a 2/4 for organic matter, a 4/4 for sedimentation, and a 3/4 for soil modification. This resulted in a soils core element score of 11.25/15.

The physical structure core element consists of the topographic complexity, edge complexity, and physical habitat richness metrics. Site 1 scored a 3/4 for topographic complexity, a 4/4 for edge complexity, and a 4/4 for physical habitat richness. This resulted in a score of 18.33/20.

The biotic structure core element consists of the plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations metrics. Site 1 scored a 4/4 on all metrics, except for species richness. Plot 1 received a 2/4 for species richness, and Sites 2-5 received a 1 for species richness. This resulted in a biotic structure core element score of 18.57/20.

The site scored well, with an overall score of 91.46 out of 100 for wetland condition. All scores for individual metrics can be found in Table 53, Appendix, page 225. This table displays the individual score (0-4) for each metric, as well as the total score for the core element.

Stephen F. Austin Experimental Forest

Using the TXRAM wetlands module assessment, the Stephen F, Austin Experimental Forest received an overall score of 89.28. A summary of the scores found at each plot for each core element is located in Table 33 on page 92. The site average was used for analysis.

Table 33. TXRAM scores for Site 2, Stephen F. Austin Experimental Forest.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Landscape | 13.13 | 13.13 | 13.13 | 13.13 | 13.13 | 13.13 |
| Hydrology | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Soils | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| Physical Structure | 18.33 | 18.33 | 18.33 | 18.33 | 18.33 | 18.33 |
| Biotic Structure | 15.71 | 16.43 | 17.14 | 16.43 | 17.14 | 16.57 |
| Total | 88.42 | 89.14 | 89.85 | 89.14 | 89.85 | 89.28 |

Site 2 scored a 3/4 on aquatic context and 4/4 on buffer. The scores of the two individual metrics are summed, divided by 8 (the total points possible), and then multiplied by 15 (the weight of the core element). This resulted in a landscape core element score of 13.13/15.

Since TXRAM is not evaluated in a specific plot size, like HGM, many of the metrics were the same across all plots, similar to HGM's site-level variables. Variation was mainly seen among plots on the species richness and non-native/invasive infestation metrics.

The hydrology core element consists of the water source, hydroperiod, and hydrologic flow metrics. Site 2 scored a 4/4 for all of these metrics. This resulted in a hydrology core element score of 30/30.

The soils core element consists of the organic matter, sedimentation, and soil modification metrics. Site 2 scored a 2/4 for organic matter, a 4/4 for sedimentation, and a 3/4 for soil modification. This resulted in a soils core element score of 11.25/15.

The physical structure core element consists of the topographic complexity, edge complexity, and physical habitat richness metrics. Site 2 scored a 3/4 for topographic complexity, a 4/4 for edge complexity, and a 4/4 for physical habitat richness. This resulted in a score of 18.33/20.

The biotic structure core element consists of the plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations metrics. Site 2 scored a 4/4 on all metrics, except for species richness and non-native/invasive infestation. Plots 1, 2, 4, and 5 received a 1/4 for species richness, and Site 3 received a 2/4 for species richness. Plot 1 received a 1 for non-native/invasive infestation, plots 2-4 received a 2, and plot 5 received a 3. This resulted in an average biotic structure core element score of 16.57/20.

The site scored well, with an overall score of 89.28 out of 100 for wetland condition. All scores for individual metrics can be found in Table 54 in the Appendix, page 226. This table displays the individual score (0-4) for each metric, as well as the total score for the core element.

<u>Alazan Wildlife Management Area</u>

Using the TXRAM wetlands module assessment, the Alazan Wildlife Management Area received an overall score of 93.82. A summary of the scores found at each plot for each core element is located below in Table 34, page 94. The site average was used for analysis.

Table 34. TXRAM scores for Site 3, Alazan Wildlife Management Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Landscape | 15 | 15 | 15 | 15 | 15 | 15 |
| Hydrology | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Soils | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| Physical Structure | 20 | 20 | 20 | 20 | 20 | 20 |
| Biotic Structure | 17.14 | 17.86 | 17.14 | 17.14 | 18.57 | 17.57 |
| Total | 93.39 | 94.11 | 93.39 | 93.39 | 94.82 | 93.82 |

Site 3 scored a 4/4 on aquatic context and 4/4 on buffer. The scores of the two individual metrics are summed, divided by 8 (the total points possible), and then multiplied by 15 (the weight of the core element). This resulted in a landscape core element score of 15/15.

Since TXRAM is not evaluated in a specific plot size, like HGM, many of the metrics were the same across all plots, similar to HGM's site-level variables. Variation was mainly seen among plots on the species richness and non-native/invasive infestation metrics.

The hydrology core element consists of the water source, hydroperiod, and hydrologic flow metrics. Site 3 scored a 4/4 for all of these metrics. This resulted in a hydrology core element score of 30/30.

The soils core element consists of the organic matter, sedimentation, and soil modification metrics. Site 3 scored a 2/4 for organic matter, a 4/4 for sedimentation, and a 3/4 for soil modification. This resulted in a soils core element score of 11.25/15.

The physical structure core element consists of the topographic complexity, edge complexity, and physical habitat richness metrics. Site 3 scored a 4/4 for topographic complexity, a 4/4 for edge complexity, and a 4/4 for physical habitat richness. This resulted in a score of 20/20.

The biotic structure core element consists of the plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations metrics. Site 3 scored a 4/4 on plant strata, interspersion, strata overlap, herbaceous cover, and vegetation alterations. Plots 2-4 received a 1 for species richness, plot 1 received a 2, and plot 5 received a 3. Plots 3-5 received a 3 for non-native/invasive infestation, plot 1 received a 2, and plot 2 received a 4. This resulted in a biotic structure core element score of 17.57/20.

The site scored well, with an overall score of 93.82 out of 100 for wetland condition. All scores for individual metrics can be found in Table 55 in the Appendix, page 227. This table displays the individual score (0-4) for each metric, as well as the total score for the core element.

Boggy Slough Conservation Area

Using the TXRAM wetlands module assessment, the Boggy Slough Conservation Area received an overall score of 89.33. A summary of the scores found at each plot for each core element is located below in Table 35, page 96. The site average was used for analysis.

Table 35. TXRAM scores for Site 4, Boggy Slough Conservation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Landscape | 13.13 | 13.13 | 13.13 | 13.13 | 13.13 | 13.13 |
| Hydrology | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Soils | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 | 11.25 |
| Physical Structure | 16.67 | 16.67 | 16.67 | 16.67 | 16.67 | 16.67 |
| Biotic Structure | 17.14 | 18.57 | 18.57 | 17.86 | 19.29 | 18.29 |
| Total | 88.18 | 89.61 | 89.61 | 88.90 | 90.33 | 89.33 |

Site 4 scored a 3/4 on aquatic context and 4/4 on buffer. The scores of the two individual metrics are summed, divided by 8 (the total points possible), and then multiplied by 15 (the weight of the core element). This resulted in a landscape core element score of 13.13/15.

Since TXRAM is not evaluated in a specific plot size, like HGM, many of the metrics were the same across all plots, similar to HGM's site-level variables. Variation was mainly seen among plots on the species richness and non-native/invasive infestation metrics.

The hydrology core element consists of the water source, hydroperiod, and hydrologic flow metrics. Site 4 scored a 4/4 for all of these metrics. This resulted in a hydrology core element score of 30/30.

The soils core element consists of the organic matter, sedimentation, and soil modification metrics. Site 4 scored a 2/4 for organic matter, a 4/4 for sedimentation, and a 3/4 for soil modification. This resulted in a soils core element score of 11.25/15.

The physical structure core element consists of the topographic complexity, edge complexity, and physical habitat richness metrics. Site 4 scored a 2/4 for topographic complexity, a 4/4 for edge complexity, and a 4/4 for physical habitat richness. This resulted in a score of 16.67/20.

The biotic structure core element consists of the plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations metrics. Site 4 scored a 4/4 on plant strata, interspersion, strata overlap, herbaceous cover, and vegetation alterations. Plots 2, 4, and 5 received a score of 3/4 for species richness, plot 1 received a 1, and plot 3 received a 2. Plots 1 and 2 received a score of 3/4 for non-native/invasive infestation, plots 3 and 5 received a 4, and plot 4 received a 2. This resulted in a biotic structure core element score of 18.29/20.

The site scored well, with an overall score of 89.33 out of 100 for wetland condition. All scores for individual metrics can be found in Table 56 in the Appendix, page 228. This table displays the individual score (0-4) for each metric, as well as the total score for the core element.

Sacul, TX

Using the TXRAM wetlands module assessment, the site near Sacul, TX, received an overall score of 74.52. A summary of the scores found at each plot for each core element is located below in Table 36, page 98. The site average was used for analysis.

Table 36. TXRAM scores for Site 5, Sacul, TX.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Landscape | 12.38 | 12.38 | 12.38 | 12.38 | 12.38 | 12.38 |
| Hydrology | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Soils | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Physical Structure | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Biotic Structure | 7.14 | 7.14 | 7.14 | 7.14 | 7.14 | 7.14 |
| Total | 74.52 | 74.52 | 74.52 | 74.52 | 74.52 | 74.52 |

Site 5 scored a 3/4 on aquatic context and 3.6/4 on buffer. The scores of the two individual metrics are summed, divided by 8 (the total points possible), and then multiplied by 15 (the weight of the core element). This resulted in a landscape core element score of 12.38/15.

Since TXRAM is not evaluated in a specific plot size, like HGM, many of the metrics were the same across all plots, similar to HGM's site-level variables. Variation was mainly seen among plots on the species richness and non-native/invasive infestation metrics.

The hydrology core element consists of the water source, hydroperiod, and hydrologic flow metrics.  Site 5 scored a 4/4 for all of these metrics.  This resulted in a hydrology core element score of 30/30.

The soils core element consists of the organic matter, sedimentation, and soil modification metrics.  Site 5 scored a 2/4 for organic matter, a 4/4 for sedimentation, and a 2/4 for soil modification.  This resulted in a soils core element score of 10/15.

The physical structure core element consists of the topographic complexity, edge complexity, and physical habitat richness metrics.  Site 5 scored a 3/4 for topographic complexity, a 4/4 for edge complexity, and a 2/4 for physical habitat richness.  This resulted in a score of 15/20.

The biotic structure core element consists of the plant strata, species richness, non-native/invasive infestation, interspersion, strata overlap, herbaceous cover, and vegetation alterations metrics.  Site 5 scored a 1/4 on plant strata, species richness, strata overlap, and herbaceous cover.  It scored a 2/4 on interspersion, a 4/4 on non-native/invasive infestation, and a 0/4 on vegetation alterations. This resulted in a biotic structure core element score of 7.14/20.

The site scored moderately well, with an overall score of 74.52 out of 100 for wetland condition. All scores for individual metrics can be found in Table 57 in the Appendix, page 229. This table displays the individual score (0-4) for each metric, as well as the total score for the core element.

## WHAP

### Lake Naconiche Mitigation Area

Using the WHAP assessment procedures, the Lake Naconiche Mitigation Area received an overall score of 69. A summary of the scores found at each plot for each component is located below in Table 37, page 100. The site average was used for analysis.

Table 37. WHAP scores for Site 1, Lake Naconiche Mitigation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | 7 | 2 | 6 | 7 | 4 | 5.2 |
| Component 5 | 5 | 4 | 5 | 5 | 4 | 4.6 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | 8 | 4 | 6 | 8 | 8 | 6.8 |
| Total | 72 | 62 | 69 | 72 | 68 | 68.6 |

Component 1 has a total of 25 points possible, component 2 has 12 possible points, component 3 has 10 possible points, component 4 has 15 points possible, component 5 has 5 points possible, component 6 has 5 points possible, and component 7 has 10 points possible.  This gives a total of 100 possible points.

WHAP is not evaluated in a specific 1/10 acre plot, like HGM, but rather in an “observable area”.  Because of this, many of the components do not exhibit much variation across the site, similar to HGM’s site-level variables.  The greatest variation between plots was observed in components 4 and 7, relating to vegetation diversity.

The individual components are summed to give a score for each plot. Component 4 and component 7 are based on two individual criterion, criterion A and criterion B.  The two criteria are summed to score the components.

Site 1 scored a 25/25 for component 1, site potential, across all plots.  If a site meets the three wetland parameters (wetland hydrology, hydrophytic vegetation, and hydric soils), it earns the highest possible score in this category.  The wetland determination parameters for this site were confirmed and are found in Figure 39a-Figure 40c in the Appendix, pages 180-185.

Component 2 received a score of 12/20 across all plots for Site 1.  This score was assigned to areas of mature timber, which are not yet old enough or large enough to be in the highest-scoring category.

Component 3 scores uniqueness and relative abundance. Site 1 was placed in the third category, receiving 10 out of 20 points. This category was assigned to this area because it exhibits high to medium value for wildlife, but it was still relatively abundant.

Component 4 is based on two criteria. Criterion A scores the diversity of woody species, and criterion B scores the total number of occurring woody species. Site 1 received a combined score of 5.4/15 for vegetation species diversity. Plots 1 and 4 received a total score of 7/15, and plot 3 received a score of 6/15. Plot 5 received a score of 4/15, and plot 2 received a score of only 2/15. Mature forested wetlands are often dominated by only a few woody species, so these lower scores were not surprising.

Site 1 received a total score of 4.6/5 for component 5, vertical vegetation stratification. All categories were well represented across the site, but plots 2 and 5 only met the second-highest criteria.

Component 6 scores a site based on the availability of structural diversity components. Nearly every plot exhibited brush piles, snags, and/or fallen logs. Site 1 received a 5/5 for this component across all plots.

Component 7 is also based two criteria. Criterion A observes the degree of utilization of woody vegetation by vertebrates and invertebrates. Criterion B records the total number of grass and forb species. Site 1 scored 4.6/5 for criterion A, with only plot 2 scoring a 3. Site 1 scored for 2.2/5 criterion B. Plots 1, 4, and 5 earned a 3 and plots 2 and 3 earned a 1. Overall, Site 1 scored a 6.8/10 for component 7.

While a score of 74 is still sufficient and likely a healthy site, it can be noted that WHAP scored Site 1 much lower than the previous three assessment methods. However, WHAP is also measuring general wildlife habitat quality, and not wetland condition like the HGM and RAM assessments do. Table 58 in the Appendix, page 230, displays all component scores for the site.

Stephen F. Austin Experimental Forest

Using the WHAP assessment procedures, the Stephen F. Austin Experimental Forest received an overall score of 68. A summary of the scores found at each plot for each component is located below in Table 38, page 103. The site average was used for analysis.

Table 38. WHAP scores for Site 2, Stephen F. Austin Experimental Forest.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | 7 | 4 | 6 | 3 | 7 | 5.4 |
| Component 5 | 4 | 5 | 5 | 5 | 5 | 4.8 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | 6 | 6 | 6 | 6 | 6 | 6 |
| Total | 69 | 67 | 69 | 66 | 70 | 68.2 |

Site 2 scored a 25/25 for component 1, site potential, across all plots. If a site meets the three wetland parameters (wetland hydrology, hydrophytic vegetation, and hydric soils), it earns the highest possible score in this category. The wetland determination parameters for this site were confirmed and are found in Figure 44a-Figure 45c in the Appendix, pages 187-192.

Component 2 received a score of 12/20 across all plots for Site 2. This score was assigned to areas of mature timber, which are not yet old enough or large enough to be in the highest-scoring category.

Component 3 scores uniqueness and relative abundance. Site 2 was placed in the third category, receiving 10 out of 20 points. This category was assigned to this area because it exhibits high to medium value for wildlife, but it was still relatively abundant.

Component 4 is based on two criteria. Criterion A scores the diversity of woody species, and criterion B scores the total number of occurring woody species. Site 2 received a combined score of 5.4/15 for vegetation species diversity, with plot scores ranging from 3/15 to 7/15. Mature forested wetlands are often dominated by only a few woody species, so these lower scores were not surprising.

Site 2 received a total score of 4.8/5 for component 5, vertical vegetation stratification. All categories were well represented across the site, but plot 1 only met the second-highest criteria.

Component 6 scores a site based on the availability of structural diversity components. Nearly every plot exhibited brush piles, snags, and/or fallen logs. Site 2 received a 5/5 for this component across all plots.

Component 7 is also based on two criteria. Criterion A observes the degree of utilization of woody vegetation by vertebrates and invertebrates. Criterion B records the total number of grass and forb species. Site 2 scored 4.6/5 for criterion A, with only plot 2 scoring a 3. Site 2 scored for 1.4/5 criterion B. Plots 1, 3, 4, and 5 earned a 1 and plot 2 earned a 3. Overall, Site 2 scored a 6/10 for component 7.

While a score of 68 is still sufficient and likely a healthy site, it can be noted that WHAP scored Site 2 much lower than the previous three assessment methods. However, WHAP is also measuring general wildlife habitat quality, and not wetland condition like the HGM and RAM assessments do. Table 59 in the Appendix, page 230, displays all component scores for the site.

<u>Alazan Wildlife Management Area</u>

Using the WHAP assessment procedures, the Alazan Wildlife Management Area received an overall score of 78. A summary of the scores found at each plot for each component is located below in Table 39, page 106. The site average was used for analysis.

Table 39. WHAP scores for Site 3, Alazan Wildlife Management Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 6 | 12 | 12 | 12 | 12 | 10.8 |
| Component 3 | 20 | 20 | 20 | 20 | 20 | 20 |
| Component 4 | 6 | 5 | 7 | 3 | 5 | 5.2 |
| Component 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | 4 | 8 | 8 | 8 | 6 | 6.8 |
| Total | 71 | 80 | 82 | 78 | 78 | 77.8 |

Site 3 scored a 25/25 for component 1, site potential, across all plots. If a site meets the three wetland parameters (wetland hydrology, hydrophytic vegetation, and hydric soils), it earns the highest possible score in this category. The wetland determination parameters for this site were confirmed and are found in Figure 50a-Figure 51c in the Appendix, pages 194-199.

Component 2 received a score of 10.8/20 across all plots for Site 1. Plot 1 scored a 6, and plots 2-5 scored a 12. A score of 12 was assigned to areas of mature timber, which are not yet old enough or large enough to be in the highest-scoring category.

Component 3 scores uniqueness and relative abundance. Site 3 was placed in the first category, receiving 20 out of 20 points. This category was assigned to this area because it exhibits high value for wildlife.

Component 4 is based on two criteria. Criterion A scores the diversity of woody species, and criterion B scores the total number of occurring woody species. Site 3 received a combined score of 5.2/15 for vegetation species diversity. Plots received scores ranging from 3/15 to 7/15. Mature forested wetlands are often dominated by only a few woody species, so these lower scores were not surprising.

Site 3 received a total score of 5/5 for component 5, vertical vegetation stratification. All categories were well represented across the site.

Component 6 scores a site based on the availability of structural diversity components. Nearly every plot exhibited brush piles, snags, and/or fallen logs. Site 3 received a 5/5 for this component across all plots.

Component 7 is also based on two criteria. Criterion A observes the degree of utilization of woody vegetation by vertebrates and invertebrates. Criterion B records the total number of grass and forb species. Site 3 scored 4.6/5 for criterion A, with only plot 1 scoring a 3. Site 3 scored for 2.2/5 criterion B. Plots 2-4 earned a 3 and plots 1 and 5 earned a 1. Overall, Site 3 scored a 6.8 for component 7.

While a score of 78 is still sufficient and likely a healthy site, it can be noted that WHAP scored Site 3 much lower than the previous three assessment methods. However, WHAP is also measuring general wildlife habitat quality, and not wetland condition like the HGM and RAM assessments do. Table 60 in the Appendix, page 231, displays all component scores for the site.

## Boggy Slough Conservation Area

Using the WHAP assessment procedures, the Boggy Slough Conservation Area received an overall score of 78. A summary of the scores found at each plot for each component is located below in Table 40, page 108. The site average was used for analysis.

Table 40. WHAP scores for Site 4, Boggy Slough Conservation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | 7 | 6 | 7 | 6 | 7 | 6.6 |
| Component 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | 10 | 8 | 6 | 10 | 10 | 8.8 |
| Total | 80 | 76 | 75 | 78 | 80 | 77.9 |

Site 4 scored a 25/25 for component 1, site potential, across all plots. If a site meets the three wetland parameters (wetland hydrology, hydrophytic vegetation, and hydric soils), it earns the highest possible score in this category. The wetland determination parameters for this site were confirmed and are found in Figure 55a-Figure 56c, Appendix, pages 201-206.

Component 2 received a score of 12/20 across all plots for Site 4. This score was assigned to areas of mature timber, which are not yet old enough or large enough to be in the highest-scoring category.

Component 3 scores uniqueness and relative abundance. Site 4 was placed in the third category, receiving 10 out of 20 points. This category was assigned to this area because it exhibits high to medium value for wildlife, but it was still relatively abundant.

Component 4 is based on two criteria. Criterion A scores the diversity of woody species, and criterion B scores the total number of occurring woody species. Site 4 received a combined score of 6.6/15 for vegetation species diversity. All plots received a score of 6/15 or 7/15. Mature forested wetlands are often dominated by only a few woody species, so these lower scores were not surprising.

Site 4 received a total score of 5/5 for component 5, vertical vegetation stratification. All categories were represented well across the site.

Component 6 scores a site based on the availability of structural diversity components. Nearly every plot exhibited brush piles, snags, and/or fallen logs. Site 4 received a 5/5 for this component across all plots.

Component 7 is also based on two criteria. Criterion A observes the degree of utilization of woody vegetation by vertebrates and invertebrates. Criterion B records the total number of grass and forb species. Site 4 scored 4.6/5 for criterion A, with only plot 3 scoring a 3. Site 4 scored for 4.2/5 criterion B. Only plots 2 and 3 scored a 3. Overall, Site 4 scored a 8.8/15 for component 7.

While a score of 78 is still sufficient and likely a healthy site, it can be noted that WHAP scored Site 4 much lower than the previous three assessment methods. However, WHAP is also measuring general wildlife habitat quality, and not wetland condition like the HGM and RAM assessments do. Table 61 in the Appendix, page 231, displays all component scores for the site.

Sacul, TX

Using the WHAP assessment procedures, the tract near Sacul, TX, received an overall score of 44. A summary of the scores found at each plot for each component is located below in Table 41, page 110. The site average was used for analysis.

Table 41. WHAP scores for Site 5, Sacul, TX.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Component 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 4 | 4 | 3 | 2 | 3 | 4 | 3.2 |
| Component 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 45 | 44 | 43 | 44 | 45 | 44 |

Site 5 scored a 25/25 for component 1, site potential, across all plots. If a site meets the three wetland parameters (wetland hydrology, hydrophytic vegetation, and hydric soils), it earns the highest possible score in this category. The wetland determination parameters for this site were confirmed and are found in Figure 59a-Figure 60c in the Appendix, pages 208-213.

Component 2 received a score of 1/20 across all plots for Site 5. This was the lowest possible score for this component, and was assigned to areas of grasses, forbs, and/or crops.

Component 3 scores uniqueness and relative abundance. Site 5 was placed in the second to last category, receiving 5 out of 20 points. This category was assigned to this area because it exhibits medium to low value for wildlife, and was still relatively abundant.

Component 4 is based on two criteria. Criterion A scores the diversity of woody species, and criterion B scores the total number of occurring woody species. Site 5 received a combined score of 3.2/15 for vegetation species diversity. Scores ranged from 1-3 for criterion A, and all plots scored a 1 for criterion B.

Site 5 received a total score of 1/5 for component 5, vertical vegetation stratification, due to the lack of vegetative cover.

Component 6 scores a site based on the availability of structural diversity components. Nearly every plot exhibited brush piles, snags, and/or fallen logs. Site 5 received a 5/5 for this component across all plots.

Component 7 is also based on two criteria. Criterion A observes the degree of utilization of woody vegetation by vertebrates and invertebrates. Criterion B records the total number of grass and forb species. Site 5 scored 0/5 for criterion A, because very little woody vegetation was present. Site 5 scored 1/5 for criterion B because so few herbaceous species were present. Overall, Site 5 scored a 1/10 for component 7.

## Summary

Sites 1-4 scored well on all SEHGM functions, with the lowest FCI score of 0.86 and the highest score of 0.99. The highest SEHGM FCI for Site 5 was 0.72 and the lowest was 0.20. The plant community and wildlife habitat functions were used for analysis because they require nearly all metrics in their calculation. Within all five sites, the wildlife habitat function scored higher than the plant community function.

Sites 1-4 also scored well on the ETXHGM assessment. The lowest FCI score was 0.86, and the highest was 1.00. The highest ETXHGM FCI for Site 5 was 0.78 and the lowest was 0.46. The plant community and wildlife habitat functions were used for analysis because they require nearly all metrics in their calculation. Both HGM assessments resulted in similar scores, particularly on Sites 1-4, which makes sense because they were based on the same approach.

TXRAM scores for Sites 1-4 were high, ranging from 94-89. Site 5 scored a 75, the highest score for this site. TXRAM scores were slightly lower than HGM scores, but still averaged around 90.

WHAP scores for Sites 1-4 were moderately high as well, ranging from 78-68. Site 5 scored a 44 from this assessment. WHAP scores were significantly lower than HGM and TXRAM across all sites, but it should be noted that WHAP is the only assessment not designed specifically as a wetland functional assessment.

## Analysis

The average results used for analysis are displayed in Table 42 below, page 113.

Table 42. Summary of results used for analysis for all assessment methods.

| | | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 |
|---|---|---|---|---|---|---|
| SEHGM | Maintain Characteristic Plant Community | 0.92 | 0.92 | 0.92 | 0.91 | 0.20 |
| | Provide Characteristic Wildlife Habitat | 0.97 | 0.97 | 0.97 | 0.96 | 0.72 |
| ETXHGM | Maintain Plant Communities | 0.90 | 0.93 | 0.95 | 0.96 | 0.59 |
| | Provide Habitat for Fish & Wildlife | 0.96 | 0.98 | 0.97 | 0.98 | 0.65 |
| TXRAM | | 0.91 | 0.89 | 0.94 | 0.89 | 0.75 |
| WHAP | | 0.69 | 0.68 | 0.78 | 0.78 | 0.44 |

One analysis compared the resulting scores using TXRAM, WHAP, and the wildlife habitat function for SEHGM and ETXHGM. The results were also compared using TXRAM, WHAP, and the plant communities function for SEHGM and ETXHGM. Each method of analysis was also performed once including the results of Site 5, and once using only the data from Sites 1-4. This helps show how the assessments compare when used on a disturbed site.

Sites 1-4 – Wildlife Function

A one-way ANOVA of the mean scores from Sites 1-4, focusing on the wildlife habitat functions for the HGM assessments, found that all assessment means were not equal. Since the F value (54.52) was greater than $F_{critical}$ ($F_{0.05(1), 3, 12}$ = 3.49; $p<0.0001$), the null hypothesis was rejected and it was concluded that at least one inequality existed between the assessment score means. Figure 2 on page 115, displays the results of the ANOVA.

ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA

The GLM Procedure

Dependent Variable: wildlife Wildlife Score

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 0.15130000 | 0.05043333 | 54.52 | <.0001 |
| Error | 12 | 0.01110000 | 0.00092500 | | |
| Corrected Total | 15 | 0.16240000 | | | |

| R-Square | Coeff Var | Root MSE | wildlife Mean |
|---|---|---|---|
| 0.931650 | 3.398191 | 0.030414 | 0.895000 |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| assess | 3 | 0.15130000 | 0.05043333 | 54.52 | <.0001 |

Figure 2. One-Way ANOVA table of mean scores for Sites 1-4 using the HGM wildlife habitat function.

A Tukey's Studentized Range test was also performed on the data. If the difference in mean scores between two assessments exceeded the minimum significant difference, those groups were not considered equal. This test grouped ETXHGM and SEHGM as statistically similar. WHAP was grouped by itself. TXRAM was grouped overlapping SEHGM, meaning a Type II error occurred. This test concludes ETXHGM ≠ TXRAM ≠ WHAP. Nothing can be concluded about SEHGM from this test due to the Type II error. An increased sample size could have made the test more conclusive. Figure 3 on page 116, displays the results of the Tukey test.

ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA

The GLM Procedure

Tukey's Studentized Range (HSD) Test for wildlife

**Note:** This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 12 |
| Error Mean Square | 0.000925 |
| Critical Value of Studentized Range | 4.19851 |
| Minimum Significant Difference | 0.0638 |

| Means with the same letter are not significantly different. | | | | |
|---|---|---|---|---|
| Tukey Grouping | | Mean | N | assess |
| | A | 0.97250 | 4 | ETXHGM |
| | A | | | |
| B | A | 0.96750 | 4 | SEHGM |
| B | | | | |
| B | | 0.90750 | 4 | TXRAM |
| | | | | |
| | C | 0.73250 | 4 | WHAP |

Figure 3. Tukey analysis of mean scores for Sites 1-4 using the HGM wildlife habitat function.

A Student-Newman-Keuls test was performed on the data as well. The SNK tends to reject the null hypothesis more often than the Tukey test because it is more powerful. This test grouped ETXHGM and SEHGM as statistically similar. TXRAM and WHAP were both grouped individually. This test suggested that ETXHGM = SEHGM ≠ TXRAM ≠ WHAP. Figure 4 on page 117, displays the results of the SNK test.

**ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA**

**The GLM Procedure**

**Student-Newman-Keuls Test for wildlife**

**Note:** This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 12 |
| Error Mean Square | 0.000925 |

| Number of Means | 2 | 3 | 4 |
|---|---|---|---|
| Critical Range | 0.0468553 | 0.0573739 | 0.0638464 |

| Means with the same letter are not significantly different. | | | |
|---|---|---|---|
| SNK Grouping | Mean | N | assess |
| A | 0.97250 | 4 | ETXHGM |
| A | | | |
| A | 0.96750 | 4 | SEHGM |
| | | | |
| B | 0.90750 | 4 | TXRAM |
| | | | |
| C | 0.73250 | 4 | WHAP |

Figure 4. SNK analysis of mean scores for Sites 1-4 using the HGM wildlife habitat function.

Sites 1-5 – Wildlife Function

A one-way ANOVA of the mean scores from Sites 1-5 (including the disturbed Site 5 assessment means), focusing on the wildlife habitat functions for the HGM assessments, found that all assessment means were not equal. Since the F value (4.55) was greater than $F_{critical}$ ($F_{0.05(1), 3, 16}$ = 3.24; p=0.0173), the null hypothesis was rejected and it was concluded that at least one inequality existed between the assessment score means. Figure 5 on page 118, displays the results of the ANOVA.

**ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA**

**The GLM Procedure**

**Dependent Variable: wildlife Wildlife Score**

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 0.19748000 | 0.06582667 | 4.55 | 0.0173 |
| Error | 16 | 0.23160000 | 0.01447500 | | |
| Corrected Total | 19 | 0.42908000 | | | |

| R-Square | Coeff Var | Root MSE | wildlife Mean |
|---|---|---|---|
| 0.460241 | 14.25499 | 0.120312 | 0.844000 |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| assess | 3 | 0.19748000 | 0.06582667 | 4.55 | 0.0173 |

Figure 5. One-Way ANOVA table of mean scores for Sites 1-5 using the HGM wildlife habitat function.

A Tukey's Studentized Range test was also performed on the data. If the difference in mean scores between two assessments exceeds the minimum significant difference, those groups were not equal. This test grouped ETXHGM, SEHGM, and TXRAM as statistically similar. WHAP was grouped by itself. TXRAM was grouped overlapping SEHGM, meaning a Type II error had occurred. This test concludes SEHGM = ETXHGM ≠ WHAP. Nothing can be concluded about TXRAM from this test due to the Type II error. An increased sample size could have made the test more conclusive. Figure 6 on page 119, displays the results of the Tukey test.

**ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA**

**The GLM Procedure**

**Tukey's Studentized Range (HSD) Test for wildlife**

**Note:** This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 16 |
| Error Mean Square | 0.014475 |
| Critical Value of Studentized Range | 4.04606 |
| Minimum Significant Difference | 0.2177 |

| Means with the same letter are not significantly different. | | | | |
|---|---|---|---|---|
| Tukey Grouping | | Mean | N | assess |
| | A | 0.91800 | 5 | SEHGM |
| | A | | | |
| | A | 0.90800 | 5 | ETXHGM |
| | A | | | |
| B | A | 0.87600 | 5 | TXRAM |
| B | | | | |
| B | | 0.67400 | 5 | WHAP |

Figure 6. Tukey analysis of mean scores for Sites 1-5 using the HGM wildlife habitat function.

A Student-Newman-Keuls test was performed on the data as well. The SNK tends to reject the null hypothesis more often than the Tukey test because it is more powerful. This test grouped ETXHGM, SEHGM, and TXRAM as statistically similar. WHAP was grouped individually. This test suggested that ETXHGM = SEHGM = TXRAM ≠ WHAP. Figure 7 on page 120, displays the results of the SNK test.

**ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA**

**The GLM Procedure**

**Student-Newman-Keuls Test for wildlife**

**Note:** This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 16 |
| Error Mean Square | 0.014475 |

| Number of Means | 2 | 3 | 4 |
|---|---|---|---|
| Critical Range | 0.1613005 | 0.1963427 | 0.2176991 |

| Means with the same letter are not significantly different. | | | |
|---|---|---|---|
| SNK Grouping | Mean | N | assess |
| A | 0.91800 | 5 | SEHGM |
| A | | | |
| A | 0.90800 | 5 | ETXHGM |
| A | | | |
| A | 0.87600 | 5 | TXRAM |
| | | | |
| B | 0.67400 | 5 | WHAP |

Figure 7. SNK analysis of mean scores for Sites 1-5 using the HGM wildlife habitat function.

<u>Sites 1-4 – Plant Communities Function</u>

A one-way ANOVA of the mean scores from Sites 1-4, focusing on the plant community functions for the HGM assessments, found that all assessment means were not equal. Since the F value (33.12) was greater than $F_{critical}$ ($F_{0.05(1), 3, 16}$ = 3.49; p<0.0001), the null hypothesis was rejected and it is concluded that at least one inequality existed between the assessment score means. Figure 8 on page 121, displays the results of the ANOVA.

ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA

The GLM Procedure

Dependent Variable: community Plant Community Score

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 0.10701875 | 0.03567292 | 33.12 | <.0001 |
| Error | 12 | 0.01292500 | 0.00107708 | | |
| Corrected Total | 15 | 0.11994375 | | | |

| R-Square | Coeff Var | Root MSE | community Mean |
|---|---|---|---|
| 0.892241 | 3.758791 | 0.032819 | 0.873125 |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| assess | 3 | 0.10701875 | 0.03567292 | 33.12 | <.0001 |

Figure 8. One-Way ANOVA table of mean scores for Sites 1-4 using the HGM plant community function.

A Tukey's Studentized Range test was also performed on the data. If the difference in mean scores between two assessments exceeded the minimum significant difference, those groups were not considered equal. This test grouped ETXHGM, SEHGM, and TXRAM as statistically similar. WHAP was grouped by itself. This test indicates ETXHGM =SEHGM = TXRAM ≠ WHAP. Figure 9 on page 122, displays the results of the Tukey test.

**ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA**

**The GLM Procedure**

**Tukey's Studentized Range (HSD) Test for community**

**Note:** This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

| | |
|---|---|
| **Alpha** | 0.05 |
| **Error Degrees of Freedom** | 12 |
| **Error Mean Square** | 0.001077 |
| **Critical Value of Studentized Range** | 4.19851 |
| **Minimum Significant Difference** | 0.0689 |

| **Means with the same letter are not significantly different.** | | | |
|---|---|---|---|
| **Tukey Grouping** | **Mean** | **N** | **assess** |
| A | 0.93500 | 4 | ETXHGM |
| A | | | |
| A | 0.91750 | 4 | SEHGM |
| A | | | |
| A | 0.90750 | 4 | TXRAM |
| | | | |
| B | 0.73250 | 4 | WHAP |

Figure 9. Tukey analysis of mean scores for Sites 1-4 using the HGM plant community function.

A Student-Newman-Keuls test was performed on the data as well. The SNK tends to reject the null hypothesis more often than the Tukey test because it is more powerful. This test grouped ETXHGM, SEHGM, and TXRAM as statistically similar. WHAP was grouped individually. This test indicates ETXHGM = SEHGM = TXRAM ≠ WHAP. Figure 10 on page 123, displays the results of the SNK test.

ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA

The GLM Procedure

Student-Newman-Keuls Test for community

**Note:** This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

| | |
|---|---|
| Alpha | 0.05 |
| Error Degrees of Freedom | 12 |
| Error Mean Square | 0.001077 |

| Number of Means | 2 | 3 | 4 |
|---|---|---|---|
| Critical Range | 0.0505606 | 0.0619111 | 0.0688954 |

| Means with the same letter are not significantly different. | | | |
|---|---|---|---|
| SNK Grouping | Mean | N | assess |
| A | 0.93500 | 4 | ETXHGM |
| A | | | |
| A | 0.91750 | 4 | SEHGM |
| A | | | |
| A | 0.90750 | 4 | TXRAM |
| | | | |
| B | 0.73250 | 4 | WHAP |

Figure 10. SNK analysis of mean scores for Sites 1-4 using the HGM plant community function.

Sites 1-5 – Plant Communities Function

A one-way ANOVA of the mean scores from Sites 1-5 (including the disturbed Site 5 assessment means), focusing on the plant community functions for the HGM assessments, it was found that all assessment means were statistically similar. Since the F value (1.17) was less than $F_{critical}$ ($F_{0.05(1), 3, 16}$ = 3.24; p=0.3525), the null hypothesis failed to be rejected and it is concluded that no inequality exists between the assessment score means. Figure 11 on page 124, displays the results of the ANOVA.

ONE-WAY ANOVA OF WETLAND ASSESSMENT METHOD DATA

The GLM Procedure

Dependent Variable: community Plant Community Score

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 0.13329500 | 0.04443167 | 1.17 | 0.3525 |
| Error | 16 | 0.60828000 | 0.03801750 | | |
| Corrected Total | 19 | 0.74157500 | | | |

| R-Square | Coeff Var | Root MSE | community Mean |
|---|---|---|---|
| 0.179746 | 24.44900 | 0.194981 | 0.797500 |

| Source | DF | Type I SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| assess | 3 | 0.13329500 | 0.04443167 | 1.17 | 0.3525 |

Figure 11. One-Way ANOVA table of mean scores for Sites 1-5 using the HGM plant community function.

# DISCUSSION

## SEHGM

$V_{WD}$ and $V_{COMP}$ were consistently the lowest individual VSIs scored across all sites, including Site 5. All other VSIs scored at least 0.80, with many scoring 1.00. In particular, the site-level variables all scored nearly 1.00. Site 5 did not assess $V_{BIG3}$ or $V_{CTDEN}$ because there was no tree stratum. $V_{GVC}$ was assessed on Site 5 instead, but only scored 0.02 because the herbaceous stratum was sparse.

Among Sites 1-4, SEHGM scored second highest among the four assessments when using the wildlife function. When all five sites were averaged using the wildlife function, SEHGM scored the highest overall. When Sites 1-4 were averaged using the plant communities function, SEHGM scored the second highest. Overall, SEHGM mean scores were first or second highest among the assessment mean scores.

When analyzing the wildlife habitat function, SEHGM scored second highest without Site 5 data, and highest when Site 5 data was included. This means that SEHGM scored Site 5 slightly higher that ETXHGM, although their scores were very similar (0.72 and 0.65, respectively). Therefore, ETXHGM was slightly more sensitive to the disturbance on Site 5.

When analyzing the plant communities function, SEHGM scored the second highest among Sites 1-4. SEHGM assigned Site 5 the lowest overall score of 0.20 for the plant communities function. In this case, SEHGM appears to be more sensitive to the disturbance on Site 5.

SNK and Tukey groupings indicated SEHGM to be statistically similar to ETXHGM in all instances. SEHGM resulted in a higher mean score when Site 5 was included in the analysis, indicating it could be less sensitive to on-site disturbance. In the instance the Tukey test encountered a Type II error in regards to SEHGM, the SNK test was conclusive.

For Sites 1-4, SEHGM resulted in very high scores. This is not surprising, since Sites 1-4 were very similar to reference standard sites for this area. For Site 5, SEHGM widely varied on function score, with a 0.20 for plant communities and a 0.72 for wildlife habitat. Site 5 was nearly clear-cut of all vegetation, so this is not surprising. However, additional study would be necessary to see if this difference among functions is significant and repeatable. Additionally, the high habitat score is due to the conditions of the surrounding areas, which were undisturbed and have little development. Some site level variables still scored highly as well, increasing the function scores.

In the field, SEHGM can be completed quickly and easily while still assessing specific on-site measurements. HGM relies on base-line data collected in the field and applied to mathematical models. It requires the collection of specific field measurements (i.e. – diameter of trees and count of woody litter pieces). However, these measurements have not been completely field validated (Cole 2015), so perhaps a system of categorical scoring would be just as effective (i.e. high = 20-30ft, med = 10-20ft, low = 0-10ft) (Fennessy et al. 2004). This could also increase repeatability and time efficiency.

One draw-back to the use of HGM is the limitation to subclass and geographic comparisons, somewhat reducing its applicability to be used for projects across multiple classes and regions. It also scores for various functions, requiring the selection of a “target function”. The chosen function would depend on the type of project and parameters that need to be assessed.

## ETXHGM

$V_{TCOMP}$, $V_{SSD}$, $V_{WD}$ were consistently the lowest individual VSIs scored across Sites 1-4. Scores for these variables were similar for Site 5 as well, but many other variables on Site 5 also scored very low. $V_{TBA}$, $V_{TDEN}$, and $V_{SSD}$ scored nearly 0.00 on Site 5 due to the absence of the tree and sapling/shrub strata. Sites 1-4 generally scored high for most variables. In particular, the site-level variables all scored nearly 1.00.

Among Sites 1-4, ETXHGM scored the highest among the four assessments when using the wildlife function. When all five sites were averaged using the wildlife function, ETXHGM scored the second highest. When Sites 1-4 were averaged using the plant communities function, ETXHGM scored the highest. Overall, ETXHGM mean scores were first or second highest among the assessment means.

When analyzing the wildlife habitat function, ETXHGM scored the highest without Site 5 data, and second highest when Site 5 data was included. This means that ETXHGM scored Site 5 slightly lower than SEHGM, although their scores were very similar (0.65 and 0.72, respectively). Therefore, ETXHGM appears to be slightly more sensitive to the disturbance on Site 5.

When analyzing the plant communities function, ETXHGM scored the highest among Sites 1-4. ETXHGM scored Site 5 a 0.59 for the plant communities function. For this function, SEHGM was more sensitive to the disturbance.

SNK and Tukey groupings indicated ETXHGM to be statistically similar to SEHGM in all instances. ETXHGM was the highest assessment mean when Site 5 was not included in the assessment, indicating it may be more sensitive overall to the disturbance at Site 5 than SEHGM.

For Sites 1-4, ETXHGM resulted in very high scores. This is not surprising, since Sites 1-4 were very similar to reference standard sites for this area.

ETXHGM is also the most regionally-specific assessment, so by resulting in the highest scores it supports the HGM calibration data. Additionally, Site 5 scores did not vary as much as those calculated by SEHGM. ETXHGM resulted in a score of 0.59 and 0.65 for the plant community and wildlife habitat functions, respectively. While these scores seem high considering the site conditions at the time of sampling, it should be noted the surrounding areas were undisturbed and many site-level variables still received high scores.

ETXHGM requires the greatest number of field metrics. However, they are generally straight forward, objective, and can be completed in a short time period. HGM relies on base-line data collected in the field and applied to mathematical models. It requires the collection of specific field measurements (i.e. – diameter and count of woody litter pieces). However, these measurements have not been completely field validated (Cole 2015), so perhaps a system of categorical scoring would be just as effective (i.e. high = 20-30ft, med = 10-20ft, low = 0-10ft) (Fennessy et al. 2004). This could also increase repeatability and time efficiency.

One draw-back to the use of HGM is the limitation to subclass and geographic comparisons, somewhat reducing its applicability to be used for projects across multiple classes and regions. It also scores for various functions, requiring the selection of a “target function”. The chosen function would depend on the type of project and parameters that need to be assessed.

## TXRAM

Species richness and non-native/invasive infestation were the lowest scoring metrics for Sites 1-4. Additionally, Site 5 was low-scoring for nearly all biotic structure metrics. Little variation in component scores was observed between Sites 1-4. Site 5 received slightly lower scores in most components, but scored significantly lower on biotic structure.

Among Sites 1-4, TXRAM scored the third highest among the four assessments when using the wildlife function. When all five sites were averaged using the wildlife function, TXRAM also scored the third highest. When Sites 1-4 were averaged using the plant communities function, TXRAM also scored the third highest. TXRAM was consistently ranked third behind ETXHGM and SEHGM.

SNK and Tukey groupings were inconclusive across analyses: TXRAM was determined to be similar to the HGMs, its own group, or statistically similar to WHAP, depending on analysis parameters. An increased sample size would help refine this relationship. In the instance the Tukey test encountered a Type II error in regard to TXRAM, the SNK test was conclusive.

For Sites 1-4, TXRAM resulted in very high scores. TXRAM scored Site 5 the highest overall, with a score of 75. This was the least amount of change observed between the Site 1-4 average score and Site 5 score. Based on this result, TXRAM appears to be the least sensitive assessment regarding anthropogenic disturbance.

TXRAM works well in conjunction with the Atlantic & Gulf Coastal Plain wetland determination sheets, requiring few additional measurements. The remaining data can be determined remotely. A drawback to RAMs in general is the issue of reproducibility. Unclear language or techniques used within the assessment have been known to be an issue (Stein et al. 2009).

TXRAM showed little decrease in overall score from those calculated by the HGMs, but it was statistically significant. Therefore TXRAM cannot be considered comparable to the HGM assessments. In most cases, the TXRAM scores was only 0.05 or less than the HGM scores. Nearly all were 0.10 or less than the HGM scores. The most notable difference is between TXRAM and the SEHGM plant communities score, in which TXRAM scored the site 0.55 higher than SEHGM. Excluding this instance, the collected field data revealed that TXRAM was on average 1.1% lower than the HGM scores.

## WHAP

Components 4 (vegetation diversity) and 7 (condition of existing vegetation) were the lowest scoring variables for the WHAP assessment across Sites 1-4. Site 5 had low scores for other components as well. Sites 1-4 were moderately high-scoring for the other components. Some variation was observed in the

WHAP scores for Sites 1-4, ranging from 68-78. Site 5 was much lower overall, scoring a 44.

Among Sites 1-4, WHAP scored the lowest among the four assessments when using the wildlife function. When all five sites were averaged using the wildlife function, WHAP also scored the lowest. When Sites 1-4 were averaged using the plant communities function, WHAP also scored the lowest. WHAP was consistently ranked lowest behind ETXHGM, SEHGM, and TXRAM.

SNK and Tukey groupings consistently placed WHAP is its own statistically different class. In one instance it was grouped similar to TXRAM, but a Type II error occurred and no conclusion could be drawn about TXRAM. In that case the SNK test was more conclusive and confirmed WHAP statistically different from TXRAM.

For Sites 1-4, WHAP resulted in relatively high scores. Site 5 scored a 44. The scores calculated for WHAP were much lower than the other assessments, but it is also a general habitat quality assessment, rather than a wetland functional assessment. It is, however, used as such in some cases. WHAP appears to be more sensitive than the other assessments to the anthropogenic disturbance encountered on Site 5.

WHAP requires a few straight forward field metrics and is truly a rapid assessment that does not “impose significant time requirements” (Texas Parks and Wildlife 1995). It does not require a demarcated plot and would be the easiest to use without any prior knowledge or training.

WHAP scored quite a bit lower than the HGMs and TXRAM, but still resulted in relatively high scores. Based on statistical differences, WHAP cannot be considered comparable to the HGM assessments or TXRAM assessment. In most cases, the WHAP score was 0.20-0.30 lower than the HGM scores. The most notable difference is between WHAP and the SEHGM plant communities score, in which WHAP scored the site 0.24 higher than SEHGM. This was the only case in which WHAP resulted in a higher score than HGM or TXRAM, but the percent difference was still consistent with all other scores. Excluding the SEHGM plant communities function score, WHAP scored an average of 24.2% lower than the HGMs.

WHAP mean scores were 0.11-0.22 lower than TXRAM mean scores for Sites 1-4. The difference between the WHAP mean score and TXRAM mean score for Site 5 was slightly higher at 0.31. Based on this data, WHAP scored an average of 19.3% lower than TXRAM.

## Comparison

In regard to individual metrics scored, nearly every plot lost the greatest number of points due to a lack of vegetative diversity. This is because bottomland hardwoods are often dominated by a few species and may have little herbaceous cover, which was observed at the sample sites.

Statistical groupings of the mean scores for each method consistently resulted in ETXHGM or SEHGM as the highest, followed by TXRAM, and then WHAP. ETXHGM and SEHGM were grouped together in all instances, TXRAM varied, and WHAP was consistently grouped alone. Further study would need to validate these rankings.

ETXHGM requires the greatest number of field metrics, but is also less subjective in the opinion of the author. SEHGM employs a similar level of objectivity as ETXHGM, but requires slightly fewer field metrics. TXRAM does not need as many field measurements, but uses several components that can be determined via knowledge of the site, aerial photography, or GIS. It is the opinion of the author that TXRAM allows a higher level of subjectivity than HGM. While WHAP requires fewer field components, they do require at least a visual inspection of the area.

In Krauss's 2013 findings, HGMi resulted in a slightly higher mitigation cost than TXRAM. These findings were confirmed through the results of this study. Among the mean scores for each method, ETXHGM and SEHGM were the highest, followed closely by TXRAM.

# CONCLUSION

Four analyses were performed on the data. In three instances, the null hypothesis was rejected, indicating the at least one inequality existed among the data. Among the three in which the results were significant, nearly all methods of grouping resulted in ETXHGM and SEHGM being statistically similar. TXRAM was similar to the HGMs, in its own group, or similar to WHAP, depending on the parameters of analysis. An increased sample size would likely reduce variation among the different analyses parameters. WHAP was consistently the lowest scoring assessment method, as expected.

TXRAM appeared to be the least sensitive, as it resulted in the highest score for the clear-cut site, Site 5. WHAP and the plant community function of SEHGM appeared to be much more sensitive, resulting in the lowest scores for Site 5 of 0.44 and 0.20, respectively.

ETXHGM requires the most field data collection, and generally resulted in one of the highest assessment scores. WHAP can be completed much more quickly, but generally resulted in a lower score. WHAP also results in a general habitat quality score, and not necessarily wetland condition. SEHGM can be completed in slightly less time than ETXHGM, and resulted in statistically similar scores.

Since SEHGM resulted in similarly high scores as ETXHGM, but required fewer metrics, it could be a more efficient assessment method.  ETXHGM is based off of the SEHGM, with a few additional field metrics.  ETXHGM baseline data is more specific to the Pineywoods ecoregion, while SEHGM baseline data is more general.  Because sampling was performed within the Pineywoods ecoregion, the highest scores were found from the method calibrated most specifically to the area.  Although SEHGM has a much larger geographic domain and slightly simpler field techniques, it resulted in nearly equally high scores.  The use of SEHGM rather than ETXHGM, particularly on a large-scale project, could reduce the amount of field work needed to assess the project, while ultimately resulting in the same score.  The geographic domain of SEHGM could also make it more applicable to a large-scale project.

Based on this study with a small sample size, ETXHGM and SEHGM appear to be comparable, assuming the comparison is made on sites within the same subclass and geographic domain.  Although it was ranked statistically different from the HGMs, TXRAM was still on average only 1.1% lower than the HGM assessments.  WHAP averaged 24.2% lower than the HGMs and 19.3% lower than TXRAM.  These percentages could be considered when making comparisons across assessments.

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APPENDIX

Site Locations

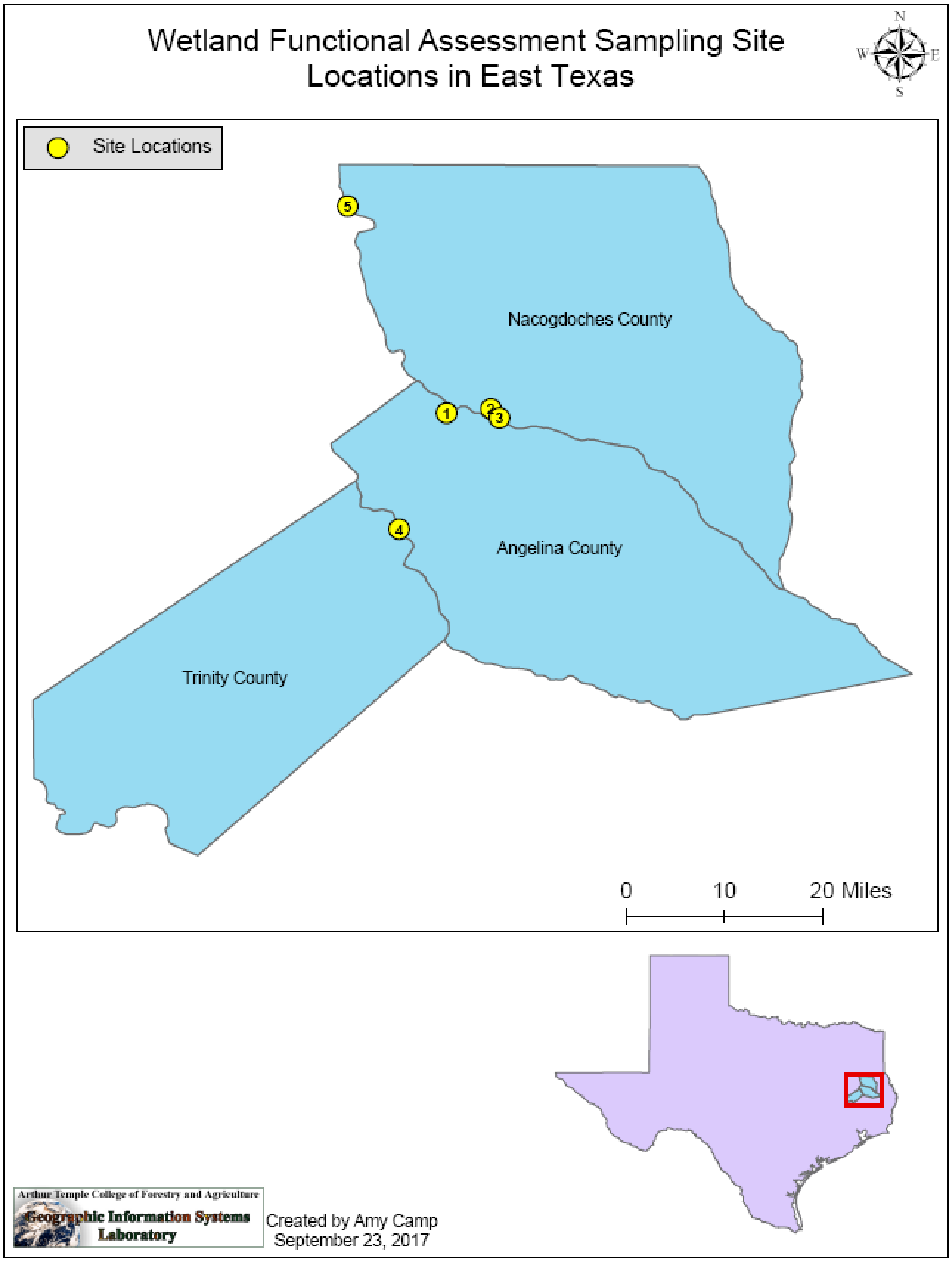



Figure 12. Locations of the five wetland functional assessment sampling sites.

Geographic Domains

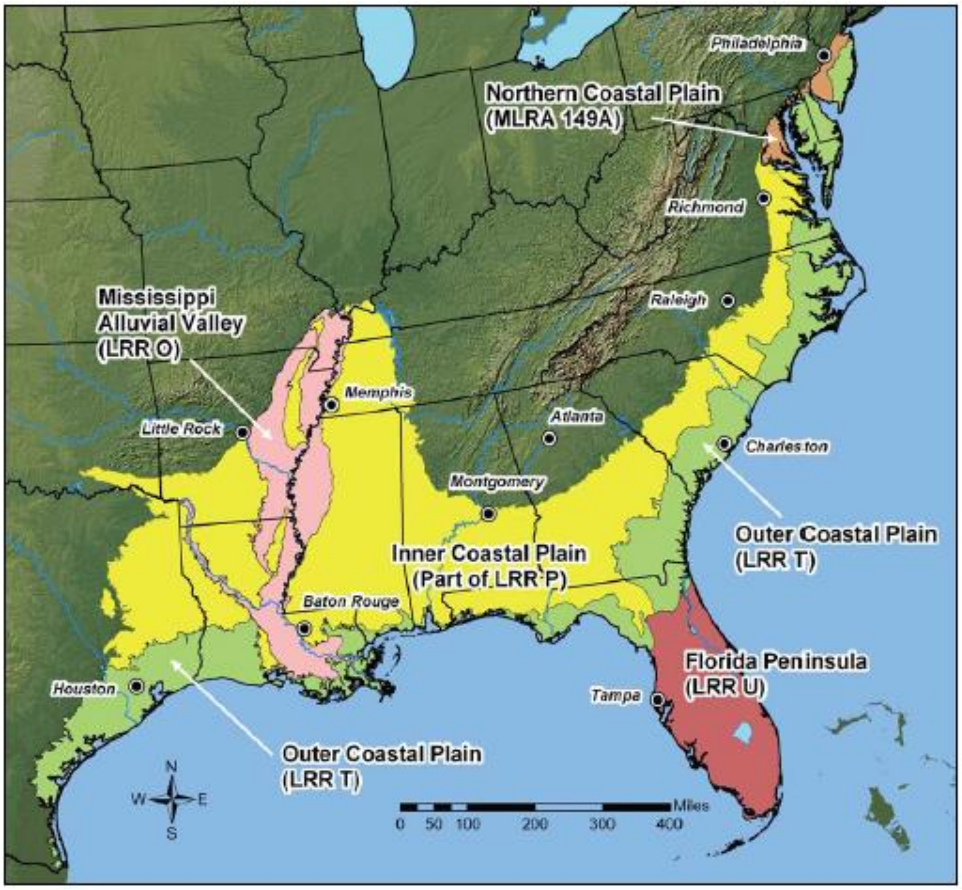



Figure 13. Geographic domain of the Atlantic and Gulf Coastal Plain regional supplement (U.S. Army Corps of Engineers 2010).

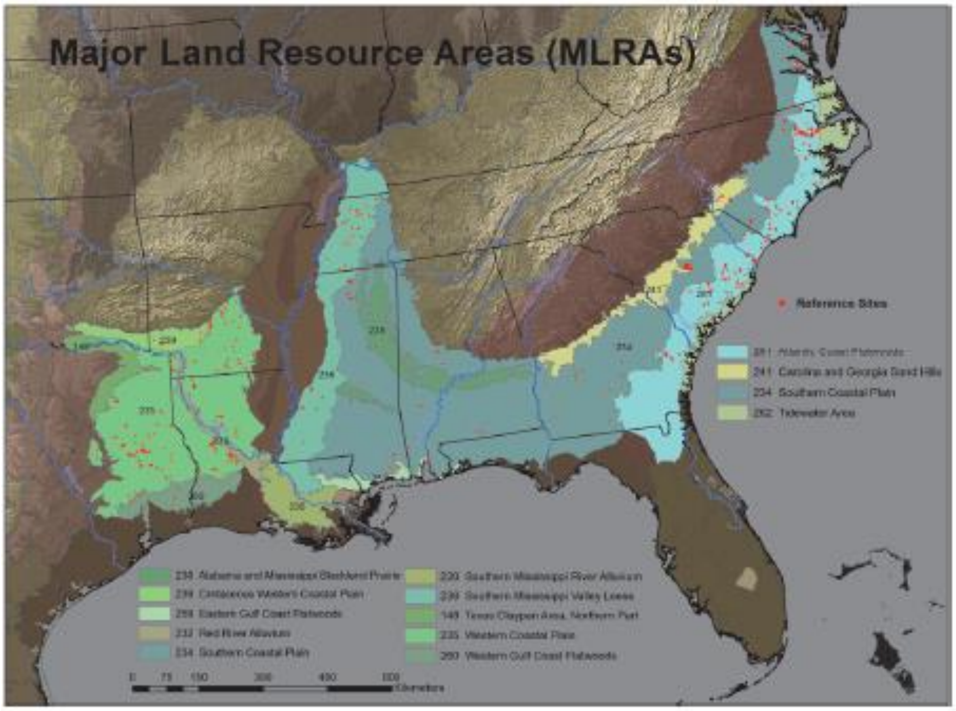



Figure 14. Reference domain for the SEHGM guidebook (Wilder et al. 2013).

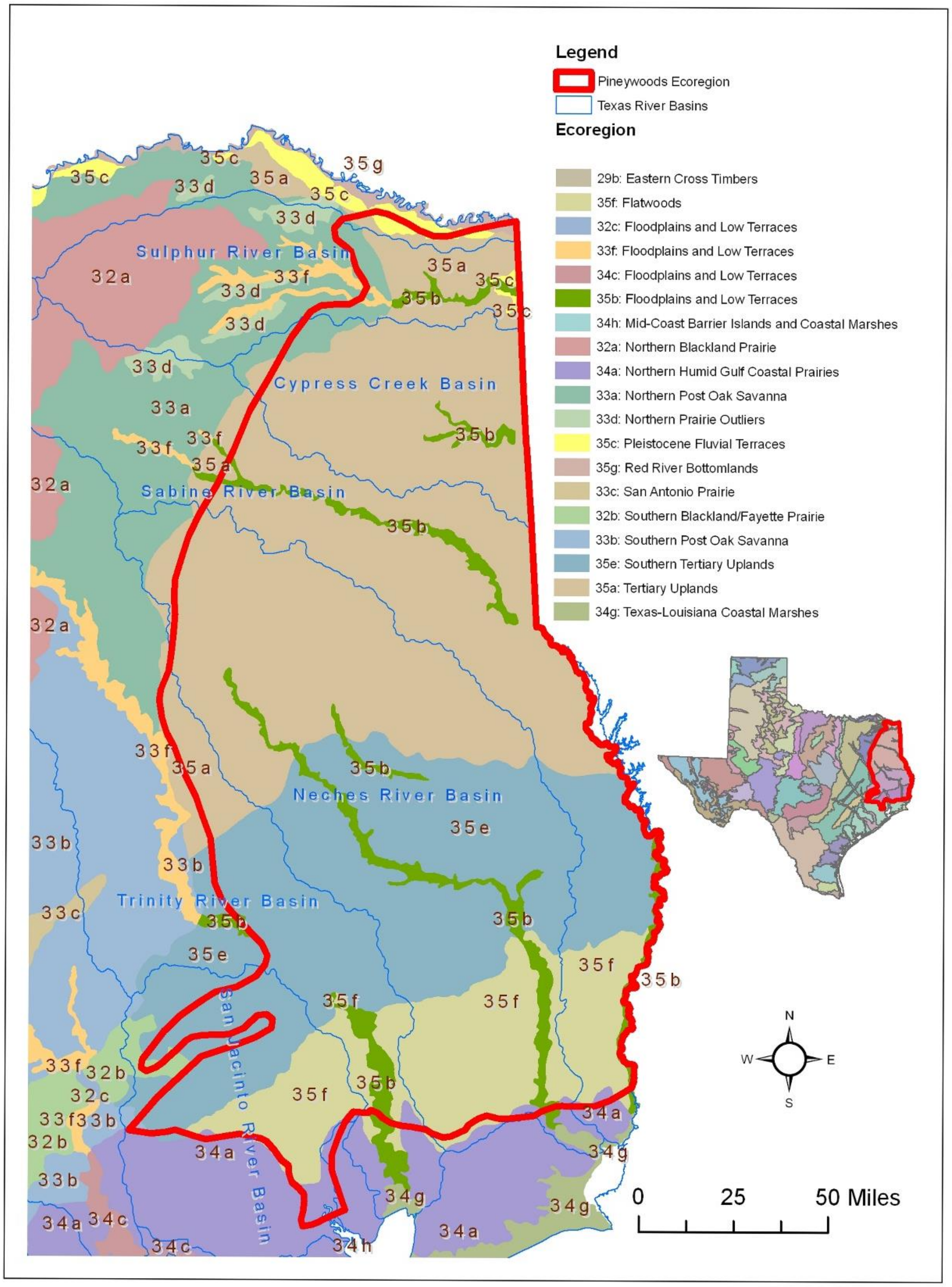



Figure 15. Reference domain for the ETXHGM guidebook (Williams et al. 2010).

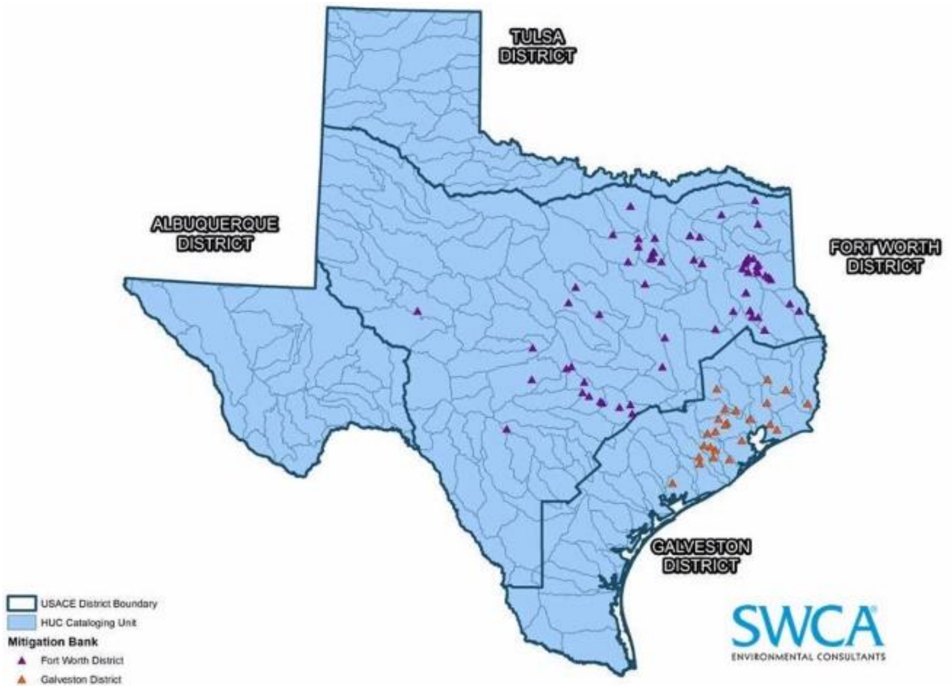



Figure 16. Geographic domain for TXRAM (U.S. Army Corps of Engineers 2010) equivalent to the boundary of the USACE Fort Worth District.

# Example Datasheets

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: ______________________ City/County: ______________ Sampling Date: ________

Applicant/Owner: ______________________________ State: ______ Sampling Point: ________

Investigator(s): ______________________ Section, Township, Range: ______________________

Landform (hillslope, terrace, etc.): ______________ Local relief (concave, convex, none): __________ Slope (%): _____

Subregion (LRR or MLRA): ____________ Lat: ____________ Long: ____________ Datum: _______

Soil Map Unit Name: ______________________________ NWI classification: ______________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes ______ | No ______ | **Is the Sampled Area within a Wetland? Yes ______ No ______** |
| Hydric Soil Present? | Yes ______ | No ______ | |
| Wetland Hydrology Present? | Yes ______ | No ______ | |
| Remarks: | | | |

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

| | | |
|---|---|---|
| __ Surface Water (A1) | __ Aquatic Fauna (B13) | |
| __ High Water Table (A2) | __ Marl Deposits (B15) **(LRR U)** | |
| __ Saturation (A3) | __ Hydrogen Sulfide Odor (C1) | |
| __ Water Marks (B1) | __ Oxidized Rhizospheres along Living Roots (C3) | |
| __ Sediment Deposits (B2) | __ Presence of Reduced Iron (C4) | |
| __ Drift Deposits (B3) | __ Recent Iron Reduction in Tilled Soils (C6) | |
| __ Algal Mat or Crust (B4) | __ Thin Muck Surface (C7) | |
| __ Iron Deposits (B5) | __ Other (Explain in Remarks) | |
| __ Inundation Visible on Aerial Imagery (B7) | | |
| __ Water-Stained Leaves (B9) | | |

Secondary Indicators (minimum of two required)

__ Surface Soil Cracks (B6)
__ Sparsely Vegetated Concave Surface (B8)
__ Drainage Patterns (B10)
__ Moss Trim Lines (B16)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)
__ Geomorphic Position (D2)
__ Shallow Aquitard (D3)
__ FAC-Neutral Test (D5)
__ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes _____ | No _____ | Depth (inches): ________ |
| Water Table Present? | Yes _____ | No _____ | Depth (inches): ________ |
| Saturation Present? (includes capillary fringe) | Yes _____ | No _____ | Depth (inches): ________ |

**Wetland Hydrology Present? Yes ______ No ______**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 17a. Page 1 of example datasheet for wetland determination following the procedures of the Atlantic and Gulf Coastal Plain regional supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Five Strata)** – Use scientific names of plants. Sampling Point: ________

| Tree Stratum (Plot size: ________ ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ____ = Total Cover | | |
| 50% of total cover: ____ | 20% of total cover: ____ | | |

| Sapling Stratum (Plot size: ________ ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ____ = Total Cover | | |
| 50% of total cover: ____ | 20% of total cover: ____ | | |

| Shrub Stratum (Plot size: ________ ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ____ = Total Cover | | |
| 50% of total cover: ____ | 20% of total cover: ____ | | |

| Herb Stratum (Plot size: ________ ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | ____ = Total Cover | | |
| 50% of total cover: ____ | 20% of total cover: ____ | | |

| Woody Vine Stratum (Plot size: ________ ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | ____ = Total Cover | | |
| 50% of total cover: ____ | 20% of total cover: ____ | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: ________ (A)

Total Number of Dominant Species Across All Strata: ________ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ________ (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | ______ | x 1 = ______ |
| FACW species | ______ | x 2 = ______ |
| FAC species | ______ | x 3 = ______ |
| FACU species | ______ | x 4 = ______ |
| UPL species | ______ | x 5 = ______ |
| Column Totals: | ______ (A) | ______ (B) |

Prevalence Index = B/A = ________

**Hydrophytic Vegetation Indicators:**

__ 1 - Rapid Test for Hydrophytic Vegetation

__ 2 - Dominance Test is >50%

__ 3 - Prevalence Index is ≤3.0[1]

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ____ No ____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 17b. Page 2 of example datasheet for wetland determination following the procedures of the Atlantic and Gulf Coastal Plain regional supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: ___________

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth | Matrix | | Redox Features | | | | | |
|---|---|---|---|---|---|---|---|---|
| (inches) | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | Texture | Remarks |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ Organic Bodies (A6) **(LRR P, T, U)**
__ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
__ Muck Presence (A8) **(LRR U)**
__ 1 cm Muck (A9) **(LRR P, T)**
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Coast Prairie Redox (A16) **(MLRA 150A)**
__ Sandy Mucky Mineral (S1) **(LRR O, S)**
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Dark Surface (S7) **(LRR P, S, T, U)**
__ Polyvalue Below Surface (S8) **(LRR S, T, U)**
__ Thin Dark Surface (S9) **(LRR S, T, U)**
__ Loamy Mucky Mineral (F1) **(LRR O)**
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ Marl (F10) **(LRR U)**
__ Depleted Ochric (F11) **(MLRA 151)**
__ Iron-Manganese Masses (F12) **(LRR O, P, T)**
__ Umbric Surface (F13) **(LRR P, T, U)**
__ Delta Ochric (F17) **(MLRA 151)**
__ Reduced Vertic (F18) **(MLRA 150A, 150B)**
__ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
__ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

__ 1 cm Muck (A9) **(LRR O)**
__ 2 cm Muck (A10) **(LRR S)**
__ Reduced Vertic (F18) **(outside MLRA 150A,B)**
__ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
__ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12)
__ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______________________

Depth (inches): ______________________

**Hydric Soil Present? Yes ______ No ______**

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 17c. Page 3 of example datasheet for soil characterization for wetland determination following the procedures of the Atlantic and Gulf Coastal Plain regional supplement (U.S. Army Corps of Engineers 2010).

**Mid- and Low-gradient Riverine Wetlands data sheets**

**Southeastern Coastal Plain HGM Field Data Sheet and Calculator**

**Site and WAA Data Form for Mid- or Low-Gradient Riverine Wetlands, Page 1 of 2**

Team: ______ WAA Number: ______

Project Name: ______

Location: ______ Sampling Date: ______

Top Strata in WAA (trees, sapling/shrub, herbs): Select Strata | Project/Mitigation Site (circle one) | Before/After Project (circle one)

**Sample Variables 1-6 using aerial photography, topographic maps, soil survey maps, etc. or a walkover of the entire WAA, as appropriate.**

1 $V_{CATCH}$ Percent change in the size of the catchment (If there is no water diversion or augmentation in the catchment, percent change = 0). **Used in Headwater Slopes Only.** — Not Used

Size of original Catchment

**If diversion:** Size of current catchment

**If augmentation:** Size of catchment from which water is being diverted.

2 $V_{UPUSE}$ Weighted Average of Runoff Score for Catchment. **Used in Headwater Slopes Only.** — Not Used

☐ **Check here if catchment is >75% in native vegetation. Other calculations are not necessary if this is the case.**

| Land Use (Choose From Drop List) | Soil Group (Choose From Drop List) | Runoff Score | % in Catchment | Running Percent (not >100) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

3a $V_{CONNECT}$ **For Headwater Slopes.** Percent of wetland perimeter connected to suitable habitat, adjusted for width of buffer (buffer must be at least 10 meters wide). — Not Used

☐ **Check here if >90% of the perimeter is clearly buffered by at least 150m of suitable habitat; no further calculations are necessary.**

Total length of wetland perimeter (meters)

Length of wetland perimeter with suitable habitat at least 10m wide (meters)

Average width of suitable habitat buffer (meters)

3b $V_{CONNECT}$ **For Riverine Subclasses.** Percent of assessment area reach with suitable habitat.

**Determine Assessment Area Reach:**

Width of alluvial valley associated with WAA (meters) (three measurements)

Avg:

Enter valley width measurements

Enter valley width measurements

Enter valley width measurements

4 $V_{SOILINT}$ Soil integrity. Estimate the percentage of the site that has significantly altered soils. Normal farm tillage is not considered a significant alteration in this case, but fill, excavation, land leveling that removes surface horizons, and compacted areas such as roads are counted.

Figure 18a. Page 1 of example datasheet for recording site-level variables for wetland functional assessment of a mid- or low-gradient riverine wetland in the Southeastern United States following the procedures of the SEHGM guidebook (Wilder et al. 2013).

**Southeastern Coastal Plain HGM Field Data Sheet and Calculator**

**Site and WAA Data Form for Mid- or Low-Gradient Riverine Wetlands, Page 2 of 2**

Project Name: ______________________ WAA Number: ________

**5 $V_{HYDROSYS}$** **Used in Riverine Subclasses Only.** System Hydrologic Alterations. It represents the capacity of a stream network above a wetland to deliver floodwaters to it. The variable expresses departure from the system's natural capacity. In the absence of other data, it can be estimated by the comparison to qualitative statements. If more precise data are available, check the box and enter an index between 0 and 1. The index represents the proportion of similarity to natural conditions. Attach supporting documentation to this form.

☐ **Check here if using external data, and select type below:** Enter Index:

☐ Stream gage data ☐ Hydrologic modeling data

☐ Channel characteristics (e.g., regional dimensionless rating curves, channel width/watershed width, sinuosity)

**If no external data are available, select one of the following (select top circle to print blank form):**

| ◉ | **Hydrologic Condition** | **Indicators** |
|---|---|---|
| ○ | Natural stream hydrology | Clear evidence of overbank flooding such as drift lines, highwater marks, etc. and floodwater exchange with stream channel. Stream flow is natural (e.g. no large reservoirs regulating flow. No clear evidence of channel incision). |
| ○ | Altered stream hydrology | Stream flow is regulated or channel is deeply incised (both conditions may be present). Evidence of overbank flooding and floodwater exchange with stream channel is present but durations and frequencies of floodwater exchange have been reduced or increased from the natural condition. |
| ○ | Hydrologically isolated – floodwater exchange with floodplain rarely or never occurs | Anthropogenic changes have resulted in the elimination of all or nearly all overbank flooding. Examples of this condition include streams with deeply incised channels (channelized system) or streams with regulated flow. |

**6a $V_{HYDROALT}$** **Used in Headwater Slopes Only.** Hydrologic Alteration within the WAA. Height of obstruction, depth of ditch, or depth of impounded water. (cm) — Not Used

Enter height of obstruction or depth of ditch (cm):

**6b $V_{HYDROALT}$** **Used in Riverine Subclasses Only.** Hydrologic Alteration within the WAA. This variable is defined as man-induced alterations to the natural hydrology of the wetland due to activities within the wetland assessment area.

**Select one of the following (select top circle to print blank form):**

| ◉ | **Hydrologic Condition** | **Indicators** |
|---|---|---|
| ○ | Natural hydrology | Clear evidence of overbank flooding (such as drift lines, highwater marks, etc.) and floodwater exchange with stream channel. No evidence of effective ditches and levees. |
| ○ | Surface hydrology modified | Site has either drainage works or obstructions to floodwater exchange with the stream, or a combination of both are present. Evidence of overbank flooding and floodwater exchange with stream channel is present. Modifications may be those intended to either reduce or increase duration or frequency of inundation at the site (departure from natural conditions, either wetter or drier, is considered an adverse impact). |
| ○ | Hydrologically isolated –rarely inundated | Primary characteristic of this condition is that anthropogenic changes have resulted in the disconnection or isolation of the wetland from overbank flooding. |
| ○ | Hydrologically isolated – never inundated by stream flow | The site is isolated due to levee systems such that overbank flow never reaches the site. |

Figure 18b. Page 2 of example datasheet for recording site-level variables for wetland functional assessment of a mid- or low-gradient riverine wetland in the Southeastern United States following the procedures of the SEHGM guidebook (Wilder et al. 2013).

**Southeastern Coastal Plain HGM Field Data Sheet and Calculator**

**Plot Data Form for Mid- or Low-Gradient Riverine Wetlands, Page 1 of 2**

Team: ____ UTM Easting: ____
Project Name: ____ UTM Northing: ____
Location: ____ Sampling Date: ____
WAA Number: ____ Plot Number: ____ of ____ Plot Area (0.04 ha is standard): 0.04

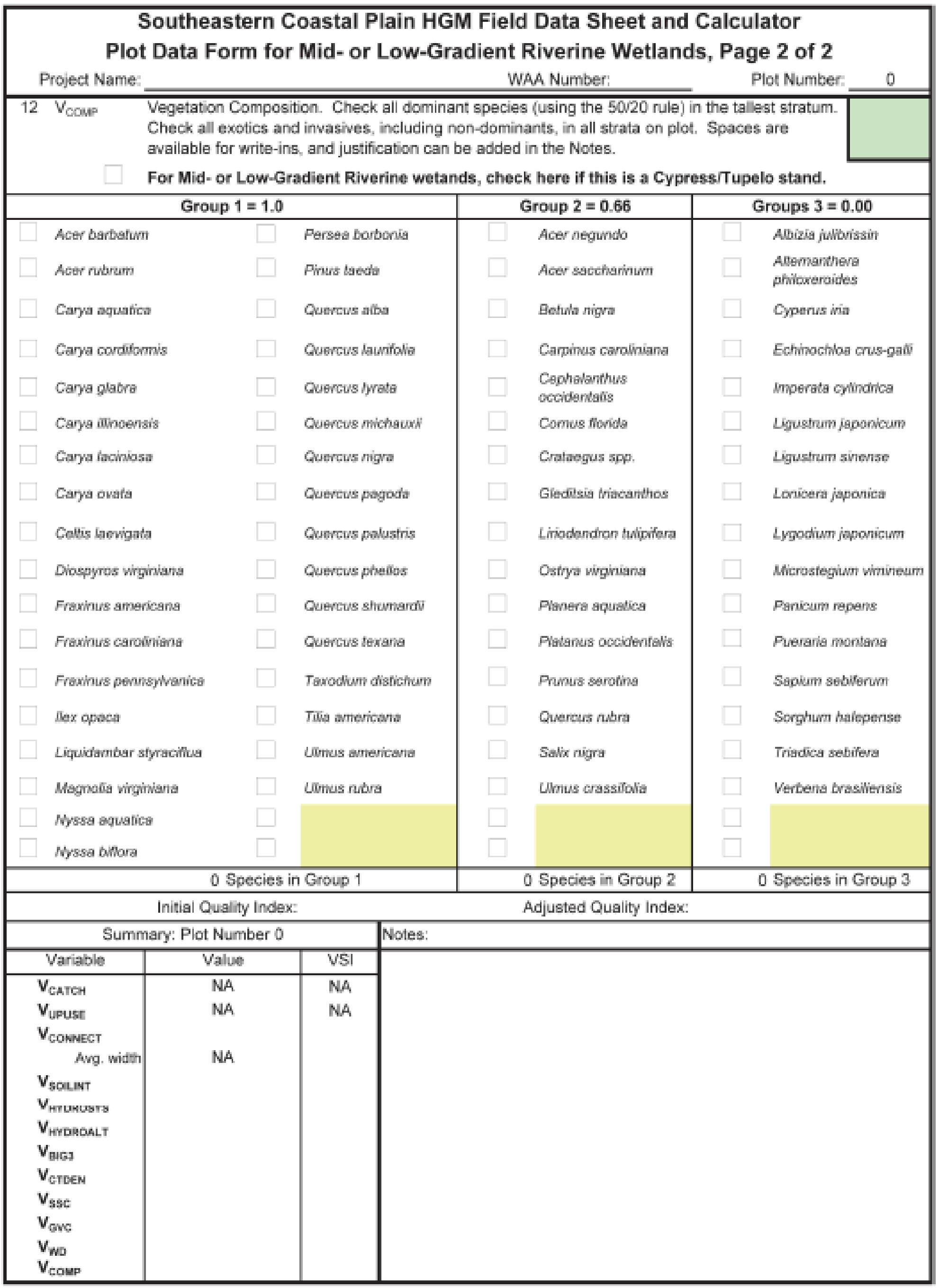
Top Strata in WAA (trees, sapling/shrub, herbs): Select Stratum | Project/Mitigation Site (circle one) | Before/After Project (circle one)

**Sample Variables 7-12 within one or more representative 0.04-ha (0.1-acre) plot(s) within the WAA (use a separate data sheet for each)**

| | | | |
|---|---|---|---|
| 7 | $V_{BIG3}$ | Average dbh of three largest-diameter canopy trees(defined as live trees >15 cm dbh) in plot. Measure only if total tree cover is at least 20%.<br>List the dbh measurements of three largest canopy trees (at least 15cm):<br>Tree 1: ____ Tree 2: ____ Tree 3: ____ | |
| 8 | $V_{CTDEN}$ | Average number of canopy trees per ha (=canopy trees in 0.04 ha plot x 25)<br>Enter number of canopy trees located in the plot: ____ | |
| 9 | $V_{SSC}$ | Average percentage cover of saplings/shrubs (measure only if site tree cover is <20% and site sapling/shrub cover >20%).<br>Subplot 1: ____ Subplot 2: ____ Subplot 3: ____ Subplot 4: ____ | |
| 10 | $V_{GVC}$ | Average percentage cover of ground-layer vegetation (measure only if tree and sapling/shrub cover are each <20%)<br>Subplot 1: ____ Subplot 2: ____ Subplot 3: ____ Subplot 4: ____ | |
| 11 | $V_{WD}$ | Large Woody Debris biomass. Volume per hectare of non-living large woody stems ($m^3$/ha). | |

| | Transect 1 | Transect 2 |
|---|---|---|
| Enter diameters (cm) of each fallen woody stem 7.6 cm (3 inches) or greater in diameter in each 50-foot transect. Leaning dead stems that intersect the sampling plane are sampled. Dead trees and shrubs still supported by their roots are not sampled. Rooted stumps are not sampled, but uprooted stumps are sampled. Down stems that are decomposed to the point where they no longer maintain their shape but spread out on the ground are not sampled.<br><br>☐ Check here if there are no logs. | | |

Figure 18c. Example datasheet for page 1 of plot-level variables used in the wetland functional assessment of a mid- or low-gradient riverine wetland in the Southeastern United States following the procedures of the SEHGM guidebook (Wilder et al. 2013).



**Southeastern Coastal Plain HGM Field Data Sheet and Calculator**

**Plot Data Form for Mid- or Low-Gradient Riverine Wetlands, Page 2 of 2**

Project Name: ______ WAA Number: ______ Plot Number: 0

12 $V_{COMP}$ Vegetation Composition. Check all dominant species (using the 50/20 rule) in the tallest stratum. Check all exotics and invasives, including non-dominants, in all strata on plot. Spaces are available for write-ins, and justification can be added in the Notes.

☐ **For Mid- or Low-Gradient Riverine wetands, check here if this is a Cypress/Tupelo stand.**

| Group 1 = 1.0 | | Group 2 = 0.66 | Groups 3 = 0.00 |
|---|---|---|---|
| ☐ *Acer barbatum* | ☐ *Persea borbonia* | ☐ *Acer negundo* | ☐ *Albizia julibrissin* |
| ☐ *Acer rubrum* | ☐ *Pinus taeda* | ☐ *Acer saccharinum* | ☐ *Alternanthera philoxeroides* |
| ☐ *Carya aquatica* | ☐ *Quercus alba* | ☐ *Betula nigra* | ☐ *Cyperus iria* |
| ☐ *Carya cordiformis* | ☐ *Quercus laurifolia* | ☐ *Carpinus caroliniana* | ☐ *Echinochloa crus-galli* |
| ☐ *Carya glabra* | ☐ *Quercus lyrata* | ☐ *Cephalanthus occidentalis* | ☐ *Imperata cylindrica* |
| ☐ *Carya illinoensis* | ☐ *Quercus michauxii* | ☐ *Cornus florida* | ☐ *Ligustrum japonicum* |
| ☐ *Carya laciniosa* | ☐ *Quercus nigra* | ☐ *Crataegus spp.* | ☐ *Ligustrum sinense* |
| ☐ *Carya ovata* | ☐ *Quercus pagoda* | ☐ *Gleditsia triacanthos* | ☐ *Lonicera japonica* |
| ☐ *Celtis laevigata* | ☐ *Quercus palustris* | ☐ *Liriodendron tulipifera* | ☐ *Lygodium japonicum* |
| ☐ *Diospyros virginiana* | ☐ *Quercus phellos* | ☐ *Ostrya virginiana* | ☐ *Microstegium vimineum* |
| ☐ *Fraxinus americana* | ☐ *Quercus shumardii* | ☐ *Planera aquatica* | ☐ *Panicum repens* |
| ☐ *Fraxinus caroliniana* | ☐ *Quercus texana* | ☐ *Platanus occidentalis* | ☐ *Pueraria montana* |
| ☐ *Fraxinus pennsylvanica* | ☐ *Taxodium distichum* | ☐ *Prunus serotina* | ☐ *Sapium sebiferum* |
| ☐ *Ilex opaca* | ☐ *Tilia americana* | ☐ *Quercus rubra* | ☐ *Sorghum halepense* |
| ☐ *Liquidambar styraciflua* | ☐ *Ulmus americana* | ☐ *Salix nigra* | ☐ *Triadica sebifera* |
| ☐ *Magnolia virginiana* | ☐ *Ulmus rubra* | ☐ *Ulmus crassifolia* | ☐ *Verbena brasiliensis* |
| ☐ *Nyssa aquatica* | ☐ | ☐ | ☐ |
| ☐ *Nyssa biflora* | ☐ | ☐ | ☐ |
| 0 Species in Group 1 | | 0 Species in Group 2 | 0 Species in Group 3 |

Initial Quality Index: Adjusted Quality Index:

Summary: Plot Number 0

Notes:

| Variable | Value | VSI |
|---|---|---|
| $V_{CATCH}$ | NA | NA |
| $V_{UPUSE}$ | NA | NA |
| $V_{CONNECT}$ | | |
| Avg. width | NA | |
| $V_{SOILINT}$ | | |
| $V_{HYDROSYS}$ | | |
| $V_{HYDROALT}$ | | |
| $V_{BIG3}$ | | |
| $V_{CTDEN}$ | | |
| $V_{SSC}$ | | |
| $V_{GVC}$ | | |
| $V_{WD}$ | | |
| $V_{COMP}$ | | |

Figure 18d. Example datasheet for page 2 of plot-level variables used in the wetland functional assessment of a mid- or low-gradient riverine wetland in the Southeastern United States following the procedures of the SEHGM guidebook (Wilder et al. 2013).

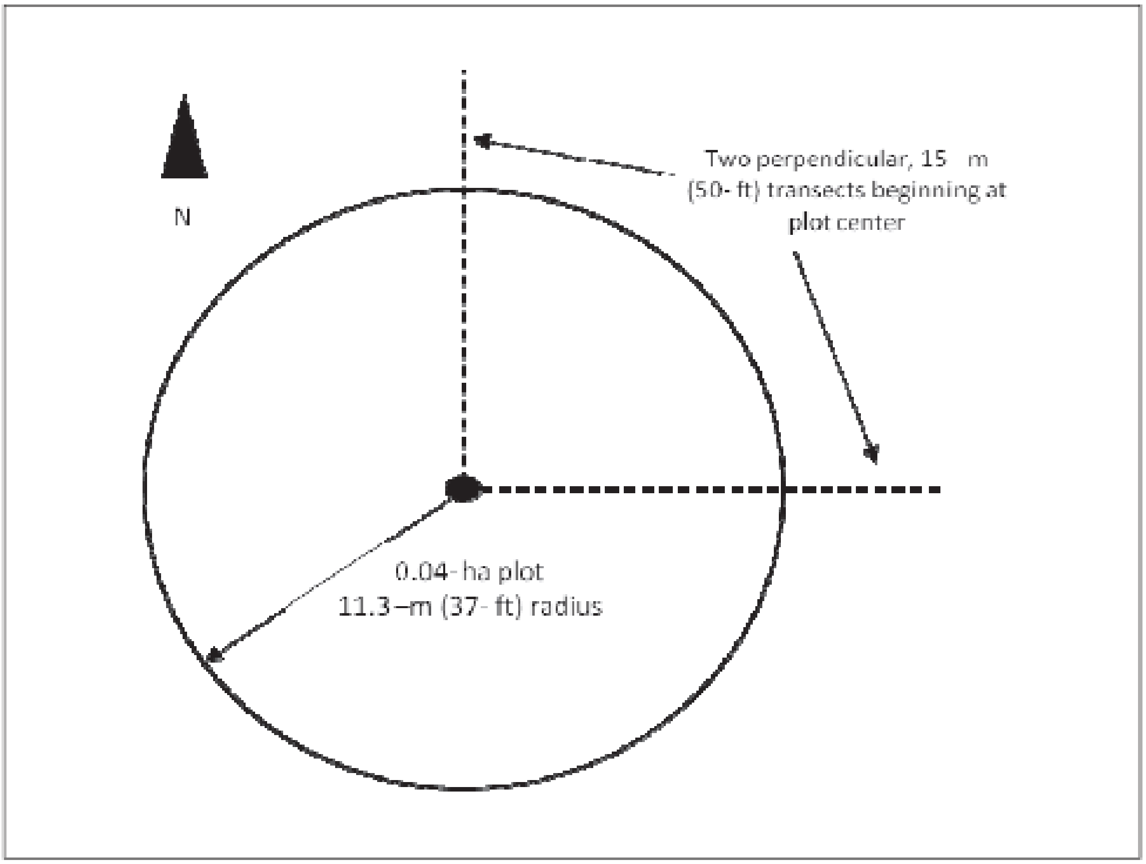


Figure 19. Plot diagram for the SEHGM guidebook (Wilder et al. 2013).

| Appendix B1-1 | Low-Gradient Riverine | Data Sheet 1<br>WAA/Tract Data | Sheet 1 of 1 |
|---|---|---|---|

These data sheets represent printouts of an electronic Excel data form that uses raw data to calculate variable indicator values, variable subindices, and ultimately functional capacity indices and units. Enter raw data in the yellow cells. When entering at the computer, use the drop down menus where provided. Green boxes are used by the calculator to run any necessary computations of the raw data before they are compared to subindex curves and translated to a variable subindex in the bottom of Data Sheet 2. Information that is relevant to the entire WAA will only be entered in Plot 1, and will be carried to the other plots and summary sheet.

## East Texas HGM Field Data Sheet and Calculator

Assessment Team: ______ UTM Easting: ______

Project Name: ______ UTM Northing: ______

Location: ______ Sampling Date: ______

WAA Number: ______ Plot Number: ______ of ______ Plot Area (0.04 ha is standard): ______

Subclass: Low-Gradient Riverine

☐ N/A Project/Mitigation Site (circle one) Before/After Project (circle one)

**Sample Variables 1-3 using aerial photography, topographic maps, soil survey maps, etc.**

| No. | Variable | Description | |
|---|---|---|---|
| 1 | $V_{PATCH}$ | Forest patch size (ha). From aerial photos or field reconnaissance, estimate the size of the forested area that is contiguous to the WAA and accessible to wildlife (including the WAA itself, if it is forested). Include both upland and wetland forests. Record the area at right. If it exceeds 2,500 ha, (6,178 acres) enter "2500." | |
| 2 | $V_{BUF30}$ | Lineal percent of wetland perimeter bounded by a full 30-m buffer of native vegetation. On a map or photo, outline a 30-m (98.5 ft) wide buffer area around the depression. Visually estimate the lineal percentage of the wetland perimeter bounded by a full 30-m buffer consisting of native vegetation. See Chapter 6 for details. Enter the percentage below.<br>Lineal percent of wetland perimeter bounded by a full 30-m buffer of native vegetation: | Not Used |
| 3 | $V_{BUF250}$ | Lineal percent of wetland perimeter bounded by a full 250-m buffer of native vegetation. On a map or photo, outline a 250-m (820-ft) wide buffer area around the depression. Visually estimate the lineal percentage of the wetland perimeter bounded by a full 250-m buffer consisting of native vegetation. See Chapter 6 for details. Enter the percentage below.<br>Lineal percent of wetland perimeter bounded by a full 30-m buffer of native vegetation: | Not Used |
| 4 | $V_{FREQ}$ | Change in flood frequency. Determine (or estimate) the frequency of flooding from streams for sites within the 5-year floodplain for both pre-project and post-project conditions. Enter 0 if this is not an assessment involving hydrologic alteration.<br>Pre-project flood return interval (years): Circle one (0, 1, 2, 3, 4, 5)<br>Post-project flood return interval (years): Circle one (0, 1, 2, 3, 4, 5) | |
| 5 | $V_{DUR}$ | Change in flood duration. Determine (or estimate) the duration of continuous flooding from streams (longest single event) during the growing season for sites within the 5-year floodplain for both pre-project and post-project conditions. Enter average weeks of continuous growing season flooding. If greater than 10, enter 10.<br>Pre-project flood duration (weeks): Circle one (0, 1 ,2 ,3, 4, 5, 6, 7, 8, 9, 10)<br>Post-project flood duration (weeks): Circle one (0, 1 ,2 ,3, 4, 5, 6, 7, 8, 9, 10) | |

**Sample Variables 4-5 during onsite field reconnaissance.**

| No. | Variable | Description | |
|---|---|---|---|
| 4 | $V_{POND}$ | Percentage of the site capable of ponding water. Estimate the area likely to pond following extended rainfall. This includes both large vernal pool sites (swales) and microdepressions such as those left by trees that have blown over and uprooted.<br>Percent ponding: | |
| 5 | $V_{STRATA}$ | Number of vegetation strata present. Vegetation layers are considered present if they account for at least 10% cover.<br>**Canopy** (trees ≥ 10 cm dbh that are in the canopy layer)<br>**Subcanopy** (trees ≥ 10 cm dbh that are below the canopy layer)<br>**Understory** (shrubs and saplings < 10 cm dbh but at least 1.4 m (4.5 ft) tall)<br>**Ground cover** (woody plants < 1.4 m (4.5 ft) tall, and herbaceous vegetation) | Choose: |
| 6 | $V_{SOIL}$ | Soil integrity. Estimate the percentage of the site that has significantly altered soils. Normal farm tillage is not considered a significant alteration in this case, but fill, land leveling that removes surface horizons, and compacted areas such as roads are counted. | |

Figure 20a. Example datasheet for page 1 of site-level variables used in the wetland functional assessment of a low-gradient riverine in East Texas following the procedures of the ETXHGM guidebook (Williams et al. 2010).

Appendix B1-2 | Low-Gradient Riverine | Data Sheet 2 - Plot Data | Sheet 1 of 2

**East Texas HGM Field Data Sheet and Calculator**

Assessment Team: ______ UTM Easting: ______
Project Name: ______ UTM Northing: ______
Location: ______ Sampling Date: ______
Plot Number: ______ of ______ Plot Area (0.04 ha is standard): 0.04

**Sample Variables 7-18 within one or more representative 0.04-ha (0.1-acre) plot(s) within the WAA (separate data sheet each plot)**

**Observations from the Center Point**

7 $V_{TBA}$ Basal area. Use a basal area wedge prism (English 10-factor) as directed, and tally eligible tree stems. The calculator automatically multiplies this tally by the conversion factor 2.3 to determine m³/ha.

Number of trees tallied ______

**Observations within a 0.04-ha plot**

8 $V_{TDEN}$ Tree density. Count the number of trees (dbh ≥ 10 cm). The calculator automatically multiplies this tally by 25 to determine stems/ha.

Number of trees tallied ______

9 $V_{SNAG}$ Snag density. Count the number of snags (standing dead trees at least 1.4 m (4.5 ft) tall and dbh ≥ 10 cm). The calculator automatically multiplies this tally by 25 to determine stems/ha.

Number of snags tallied ______

10 $V_{OHOR}$ Thickness of the O horizon. Select two or more points within the plot that are representative of the range of microtopography within the plot as a whole. Dig a hole and measure the thickness of the O horizon (organic accumulation on the soil surface, excluding fresh litter, but including surface root mats if present).

Subplot 1: ______ Subplot 2: ______ Subplot 3: ______ Subplot 4: ______

11 $V_{AHOR}$ Thickness of the A horizon. In the same holes as above, measure the thickness of the A horizon (mineral soil with incorporated organic matter, indicated by distinct darkening relative to lower horizons).

Subplot 1: ______ Subplot 2: ______ Subplot 3: ______ Subplot 4: ______

12 $V_{COMP}$ Composition of tallest woody vegetation stratum, percent concurrence. If tree cover is ≥ 20%, use the 50/20 rule (see Williams *et al.* 2010 for details) and check the dominant trees in Columns A, B, and C. If a dominant does not appear on the list, use local knowledge or literature to assign it to the appropriate column. If tree cover is < 20%, identify the next tallest woody stratum with at least 10% cover.

13 $V_{TCOMP}$ Tree composition. ☐ Check box if tree cover is greater than or equal to 20%, and the composition concurrence below is for the tree stratum.

| Group 1 = 1.0 | Group 2 = 0.66 | Groups 3 = 0.33 |
|---|---|---|
| ☐ *Nyssa sylvatica* | ☐ *Acer rubrum* | ☐ *Carpinus caroliniana* |
| ☐ *Quercus laurifolia* | ☐ *Diospyros virginiana* | ☐ *Crategus spp.* |
| ☐ *Quercus michauxii* | ☐ *Fraxinus spp* | ☐ *Ilex vomitoria* |
| ☐ *Quercus nigra* | ☐ *Ilex decidua* | ☐ *Morus rubra* |
| ☐ *Quercus pagoda* | ☐ *Liquidambar styraciflua* | ☐ *Triadica sebifera* |
| ☐ *Quercus phellos* | ☐ *Platanus occidentalis* | ☐ |
| ☐ *Quercus nuttallii* | ☐ *Quercus lyrata* | ☐ |
| ☐ — | ☐ *Ulmus spp* | ☐ |
| ☐ — | ☐ — | |
| ☐ — | ☐ — | |
| ☐ | ☐ — | |
| ☐ | ☐ | |
| ☐ | ☐ | |
| | ☐ | |
| 0 Species in Group 1 | 0 Species in Group 2 | 0 Species in Group 3 |

Using the dominant species circled in Columns A, B, and C above, percent concurrence is calculated automatically according to the following formula:

{[( 1.0 * number of circled dominants in Column A ) + ( 0.66 * number of circled dominants in Column B ) + (0.33 * number of circled dominants in Column C)] / total number of circled dominants in all columns} x 100 = _____ %

Figure 20b. Example datasheet for page 1 of plot-level variables used in the wetland functional assessment of a low-gradient riverine in East Texas following the procedures of the ETXHGM guidebook (Williams et al. 2010).

| Appendix B1-2 | Low-Gradient Riverine | Data Sheet 2 - Plot Data | Sheet 2 of 2 |
|---|---|---|---|

**Observations within two 0.004-ha plots.** From the center point, measure north and south 5 m and establish two circular subplots with a radius of 3.6 m (11.8 ft). Within each subplot, measure the following:

14 $V_{SSD}$ Shrub/Sapling density. Count the number of woody stems that are at least 1.4 m (4.5 ft) tall, but less than 10 cm dbh in each subplot. The calculator multiplies the sum of both plots to determine understory stems/ha.

Subplot 1: Subplot 2:

**Observations within 4 1-m × 1-m square subplots.** From the center point, measure 5 m in each cardinal direction and establish a 1-m × 1-m square subplot. Within each subplot record the following:

15 $V_{GVC}$ Ground vegetation cover. Estimate the percent cover of all herbaceous plants and woody plants < 1.4 m (4.5 ft) tall. The calculator automatically averages the results of the four subplots.

Subplot 1: Subplot 2: Subplot 3: Subplot 4:

16 $V_{LITTER}$ Litter cover. Estimate the percent of the plot area covered by undecomposed litter. The calculator automatically averages the results of the four subplots.

Subplot 1: Subplot 2: Subplot 3: Subplot 4:

**Observations along transects.**

17 $V_{LOG}$ Log biomass. Volume per hectare of non-living fallen logs ($m^3$/ha).

18 $V_{WD}$ Woody debris biomass. Volume per hectare of non-living fallen woody stems ($m^3$/ha).

| | Transect 1 | Transect 2 |
|---|---|---|
| Number of stems with diameters greater than or equal to 0.6 cm (0.25 in) and less than 2.5 cm (1 in) in diameter intersecting a 6-ft length of the 50-foot transect: | | |
| Number of stems with diameters greater than or equal to 2.5 cm (1 in) and less than 7.6 cm (3 in) in diameter intersecting a 6-ft length of the 50-foot transect: | | |
| Enter diameters (cm) of each fallen woody stem 7.6 cm (3 inches) or greater in diameter in each 50-foot transect: | | |

| Plot Summary | | |
|---|---|---|
| Variable | Value | VSI |
| $V_{PATCH}$ | | |
| $V_{BUF30}$ | Not Used | |
| $V_{BUF250}$ | Not Used | |
| $V_{FREQ}$ | | |
| $V_{DUR}$ | | |
| $V_{POND}$ | | |
| $V_{STRATA}$ | | |
| $V_{SOIL}$ | | |
| $V_{TBA}$ | | |
| $V_{TDEN}$ | | |
| $V_{SNAG}$ | | |
| $V_{OHOR}$ | | |
| $V_{AHOR}$ | | |
| $V_{COMP}$ | | |
| $V_{TCOMP}$ | | |
| $V_{SSD}$ | | |
| $V_{GVC}$ | | |
| $V_{LITTER}$ | | |
| $V_{LOG}$ | | |
| $V_{WD}$ | | |

Notes:

Figure 20c. Example datasheet for page 2 of plot-level variables used in the wetland functional assessment of a low-gradient riverine in East Texas following the procedures of the ETXHGM guidebook (Williams et al. 2010).

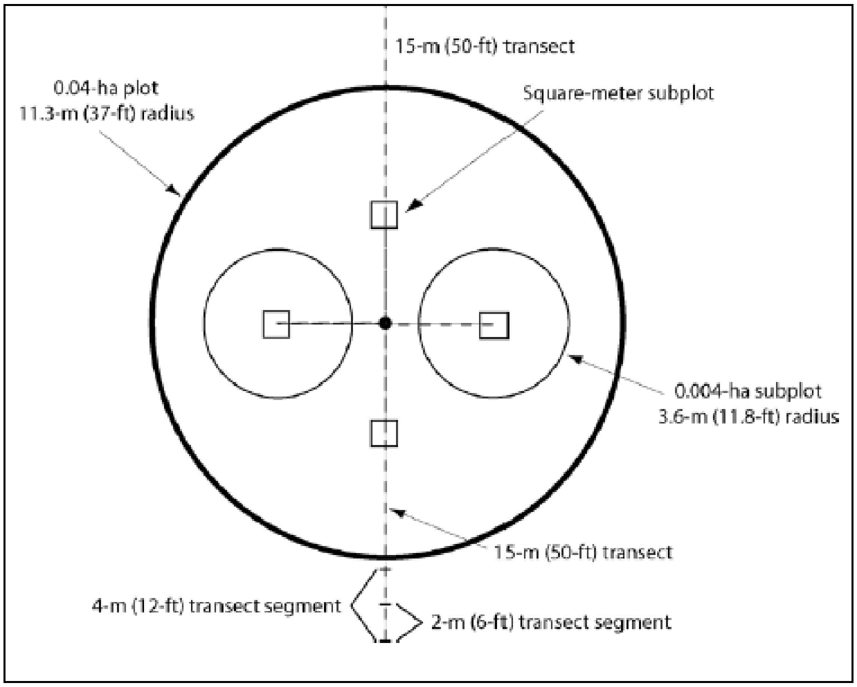



Figure 21. Plot diagram for the ETXHGM guidebook (Williams et al. 2010).

*Version 2.0 – Final*

**TXRAM WETLAND DATA SHEET**

Project/Site Name/No.: ______________________ Project Type: ☐ Fill/Impact (☐ Linear ☐ Non-linear) ☐ Mitigation/Conservation

Wetland ID/Name: __________ WAA No.: __________ Size: __________ Date: __________ Evaluator(s): ______________

Wetland Type: ______________ Ecoregion: ______________________ Delineation Performed: ☐ Previously ☐ Currently

Aerial Photo Date and Source: ______________________ Site Photos: ______________ Representative: ☐ Yes ☐ No

Notes:

**LANDSCAPE**

***Aquatic Context – Confirm in office review. See figures in section 2.3.1.1 for examples.***

Notes on any barriers or alterations that prevent connection: ______________________

Aquatic resources within 1,000 feet of WAA to which wetland connects (including number for other considerations):_____ **Score:** _____

***Buffer – Evaluate to 500 feet from WAA boundary. Confirm in office review. See figures in section 2.3.1.2 for examples.***

| *Buffer Type/Description* | *Score (See Narratives)* | *Percentage* | *Subtotal* |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

**Score:** _____

**HYDROLOGY**

***Water Source – Degree of natural or unnatural/artificial influence. Confirm in office review for watershed.***

Natural: ☐ Precipitation ☐ Groundwater ☐ Overbank flow/stream discharge ☐ Overland flow ☐ Beaver activity ☐ Other: _______

Unnatural/Manipulated: ☐ Impoundment ☐ Outfall ☐ Irrigation/pumping ☐ Other artificial influence or control: __________

Watershed: ☐ Development ☐ Irrigated agriculture ☐ Wastewater treatment plant ☐ Impoundment ☐ Other: __________

Degree of artificial influence/control: ☐ Complete ☐ High ☐ Low ☐ None

Wetland created/restored/enhanced: ☐ Sustainable/replicates natural ☐ Controlled **Score:** _____

***Hydroperiod – Variability and recent alteration of the duration, frequency, and magnitude of inundation/saturation.***

Evaluate the hydroperiod including natural variation: ______________________

Direct evidence of alteration: Natural: ☐ Log-jam ☐ Channel migration ☐ Other: ______________

Human: ☐ Diversions ☐ Ditches ☐ Levees ☐ Impoundments ☐ Other: ______________

Riverine only: ☐ Recent channel in-stability/dis-equilibrium (☐ Degradation or ☐ Aggradation)

Indirect evidence of alteration: ☐ Wetland plant stress: __________ ☐ Plant morphology: __________

☐ Upland species encroachment: __________ ☐ Plant Community: __________ ☐ Soil: __________

Change/Alteration of hydroperiod: ☐ None ☐ Due to natural events ☐ Human influences (☐ Slight or ☐ High)

Degree hydroperiod of wetland created/restored/enhanced replicates natural patterns: ______________

Lacustrine fringe on human impoundment: ☐ High variability ☐ Low variability ☐ Recent changes to hydroperiod **Score:** _____

***Hydrologic Flow – Movement of water to or from surrounding area and openness to water moving through the WAA.***

Flow: ☐ Inlets: _____ ☐ Outlets: _____ ☐ Signs of water movement to or from WAA: ______________

Restrictions: ☐ Levee ☐ Berm/dam ☐ Diversion ☐ Other: ______________

High flowthrough: ☐ Floodplain ☐ Drift deposits ☐ Drainage patterns ☐ Sediment deposits ☐ Other: __________

Low flowthrough: ☐ High landscape position ☐ Stagnant water ☐ Closed contours ☐ Other: __________ **Score:** _____

**SOILS**

***Organic Matter – Use data and indicators from wetland determination data form(s) based on applicable regional supplement.***

☐ High (organic soil or indicator A1, A2, A3)

☐ Moderate (indicator A9, S1, F1 in AW or A9, S1, S2, F1 in GP or A6, A7, A9, S7, F13 in AGCP)

☐ Low (indicated by thin organic or organic-mineral layer) ☐ None observable in surface layer as described herein **Score:** _____

Figure 22a. Example datasheet for page 1 of variables used in the TXRAM wetland assessment (U.S. Army Corps of Engineers 2010).

***Sedimentation – Deposition of excess sediment due to human actions. Confirm in office review for landscape.***

Landscape with stress that could lead to excess sedimentation? ☐ Yes ☐ No Landscape position: ☐ High ☐ Low

Magnitude of recent runoff/flooding events: ☐ High ☐ Low Percent of WAA with excess sediment deposition: _____

☐ Sand deposits: _____% of area, _____ average thickness ☐ Silt/Clay deposits: _____% of area, _____ average thickness

Lacustrine fringe only: ☐ Upper end of impoundment ☐ Degrades wetland ☐ Contributes to wetland processes **Score:** _____

***Soil Modification – Physical changes by human activities. Confirm in office review for past.***

Type (Check those applicable and circle R for recent or P for past): ☐ Farming R/P ☐ Logging R/P ☐ Mining R/P ☐ Filling R/P

☐ Grading R/P ☐ Dredging R/P ☐ Off-road vehicles R/P ☐ Other R/P: ____________________

Percent of WAA with recent soil modification: _____% Degree of modification: ☐ High ☐ Low

Indicators of past modification: ☐ High bulk density ☐ Low organic matter ☐ Lack of soil structure ☐ Lack of horizons ☐ Hardpan

☐ Dramatic change in texture/color ☐ Heterogeneous mixture ☐ Other: ____________________

Indicators of recovery: ☐ Organic matter ☐ Structure ☐ Horizons ☐ Mottling ☐ Hydric soil ☐ Other: ____________________

Percent of WAA with past modification: _____% Recovery: ☐ Complete ☐ High ☐ Moderate ☐ Low ☐ None **Score:** _____

**PHYSICAL STRUCTURE**

***Topographic Complexity – See figures in section 2.3.4.1. Record % micro-topography and % WAA for each elevation gradient.***

Elevation gradients (EG): _____ Evidence: ☐ Plant assemblages ☐ Level of saturation/inundation ☐ Path of water flow ☐ Slope

Micro-topography: _____% of WAA (By EG: ____________________)

Types: ☐ Depressions ☐ Pools ☐ Burrows ☐ Swales ☐ Wind-thrown tree holes ☐ Mounds ☐ Gilgai ☐ Islands

☐ Variable shorelines ☐ Partially buried debris ☐ Debris jams ☐ Plant hummocks/roots ☐ Other:__________ **Score:** _____

***Edge Complexity – Confirm in office review. See figure in section 2.3.4.2 to evaluate wetland boundary.***

WAA: ☐ In seasonal floodplain ☐ Contiguous to other wetland ☐ Edge vertical structure variation: ____________________

Horizontal variability: ☐ High ☐ Moderate ☐ Low ☐ None **Score:** _____

***Physical Habitat Richness – See definitions and table in section 2.3.4.3 for habitat types applicable to each wetland type.***

Label of habitat types qualifying as present in WAA: ____________________Total: _____ **Score:** _____

**BIOTIC STRUCTURE**

***Plant Strata – Use applicable wetland delineation regional supplement and data from determination data form(s).***

Number of plant strata: ☐ ≥ 4 ☐ 3 ☐ 2 ☐ 1 ☐ 0 **Score:** _____

***Species Richness – Use data from determination data form(s) to count species with 5% or more relative cover in a stratum.***

Number of species across all strata and determination data forms (not counting a species more than once): __________ **Score:** _____

***Non-Native/Invasive Infestation – Use data from determination data form(s). See tables in section 2.3.5.3 for examples.***

Average total relative cover of non-native/invasive species across all strata and determination data forms: __________% **Score:** _____

***Interspersion – Confirm in office review. Use figure in section 2.3.5.4 to determine the degree of interspersion of plant zones.***

Degree of horizontal/plan view interspersion: ☐ High ☐ Moderate ☐ Low ☐ None ☐ Bottomland hardwood forest **Score:** _____

***Strata Overlap – Use strata defined in plant strata metric using applicable regional supplement. See figures in section 2.3.5.5.***

High overlap (≥ 3 strata overlapping): ___________% of WAA Moderate overlap (2 strata overlapping): ___________% of WAA

Herbaceous species/dense litter overlap (only in portion where there are no other strata overlapping): ___________% of WAA

Total percentage of WAA with some form of overlap (if more than one present): ____________________% of WAA **Score:** _____

***Herbaceous Cover – Estimate for entire WAA.*** In South Central Plains or East Central Texas Plains: ☐ Bottomland hardwood forest

Total cover of emergent and submergent plants: ☐ > 75% ☐ 51–75% ☐ 26–50% ☐ ≤ 25% **Score:** _____

***Vegetation Alterations – Unnatural (human-caused) stressors. Confirm in office review for past.***

Type (Check those applicable and circle R for recent or P for past): ☐ Disking R/P ☐ Mowing/shredding R/P ☐ Logging R/P

☐ Cutting R/P ☐ Trampling R/P ☐ Herbicide treatment R/P ☐ Herbivory R/P ☐ Disease R/P ☐ Chemical spill R/P

☐ Pollution R/P ☐ Feral hog rooting R/P ☐ Woody debris removal R/P ☐ Other R/P: ____________________

Percent of WAA with recent vegetation alteration: _____% Severity of alteration: ☐ High ☐ Low

Percent of WAA with past vegetation alteration: _____% Degree of recovery: ☐ Complete ☐ High ☐ Moderate ☐ Low

☐ Alteration to improve wetland (degree of natural community recovery):____________________ **Score:** _____

Figure 22b. Example datasheet for page 2 of variables used in the TXRAM wetland assessment (U.S. Army Corps of Engineers 2010).

TEXAS PARKS & WILDLIFE

**Wildlife Habitat Appraisal Procedure**
**Biological Components Field Evaluation**

Project: ______________________________ Date: ____________

Cover Type or Plant Association: ______________________________

| **Habitat Components** | **Component Points (from Key)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Site No.** | | | | | | | | **Total** |
| 1. Site Potential | | | | | | | | |
| 2. Temporal Development | | | | | | | | |
| Criteria A | | | | | | | | |
| Criteria B (Marsh Wetlands Only) | | | | | | | | |
| 3. Uniqueness and Relative Abundance | | | | | | | | |
| 4. Vegetation Species Diversity | | | | | | | | |
| Criteria A | | | | | | | | |
| Criteria B | | | | | | | | |
| Criteria C (Swamps Only) | | | | | | | | |
| Criteria D (Marsh Wetlands Only) | | | | | | | | |
| 5. Vertical Stratification | | | | | | | | |
| 6. Additional Structural Diversity Components | | | | | | | | |
| 7. Condition of Existing Vegetation | | | | | | | | |
| Criteria A (Woody Vegetation) | | | | | | | | |
| Criteria B (Herbaceous Vegetation) | | | | | | | | |
| Criteria C (Croplands Only) | | | | | | | | |
| Criteria D (Marsh Wetlands Only) | | | | | | | | |

Average Habitat Quality Score for all Sites within this cover type = $\frac{\text{Total Points}}{\text{Total number of sites}} \times \frac{1}{100}$ = ______

Figure 23. Example datasheet for WHAP wetland assessment (Texas Parks and Wildlife 1995).

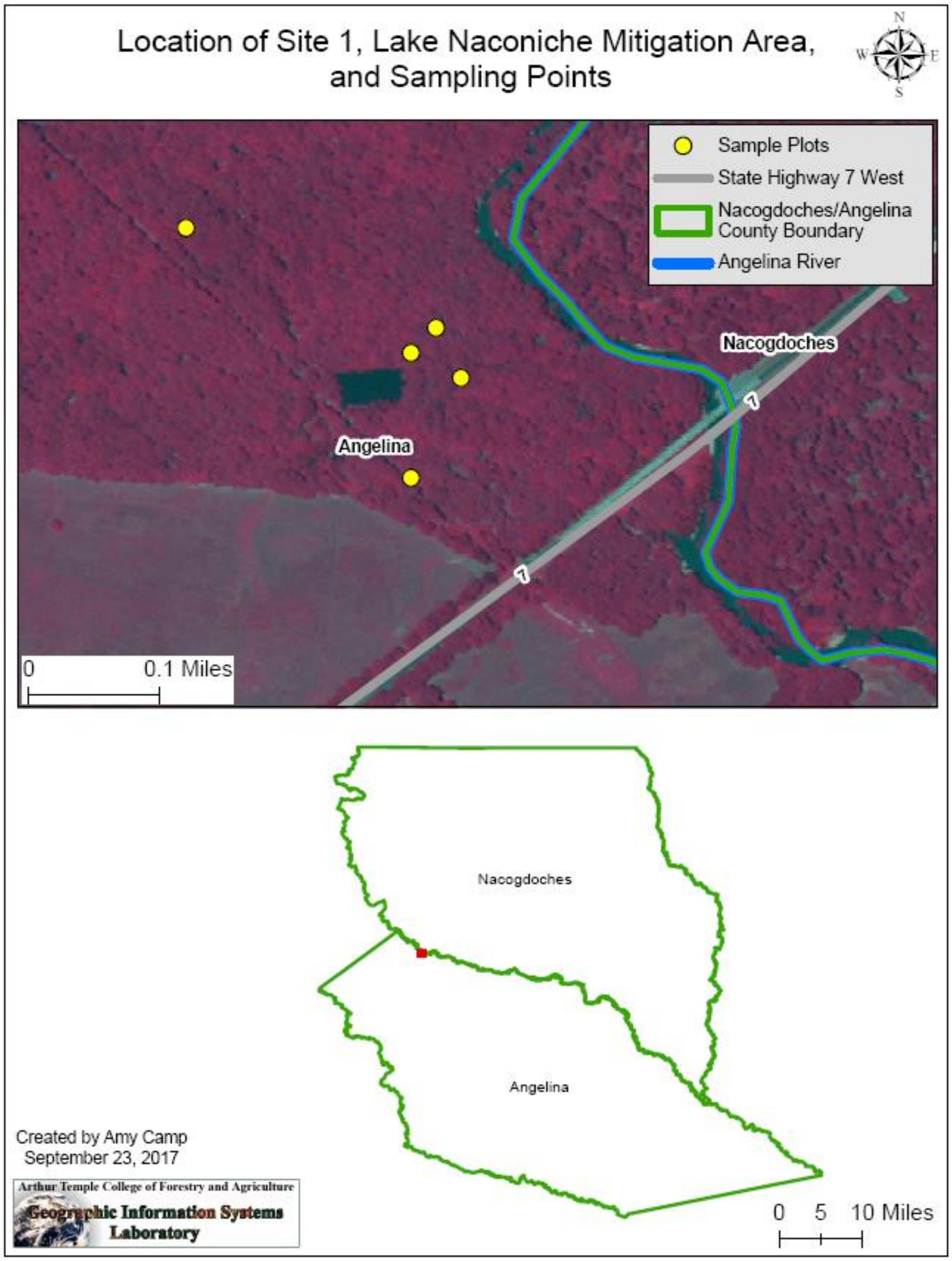



Figure 24. Location of Site 1, Lake Naconiche Mitigation Area in Angelina County, TX, and subsequent sampling plots.

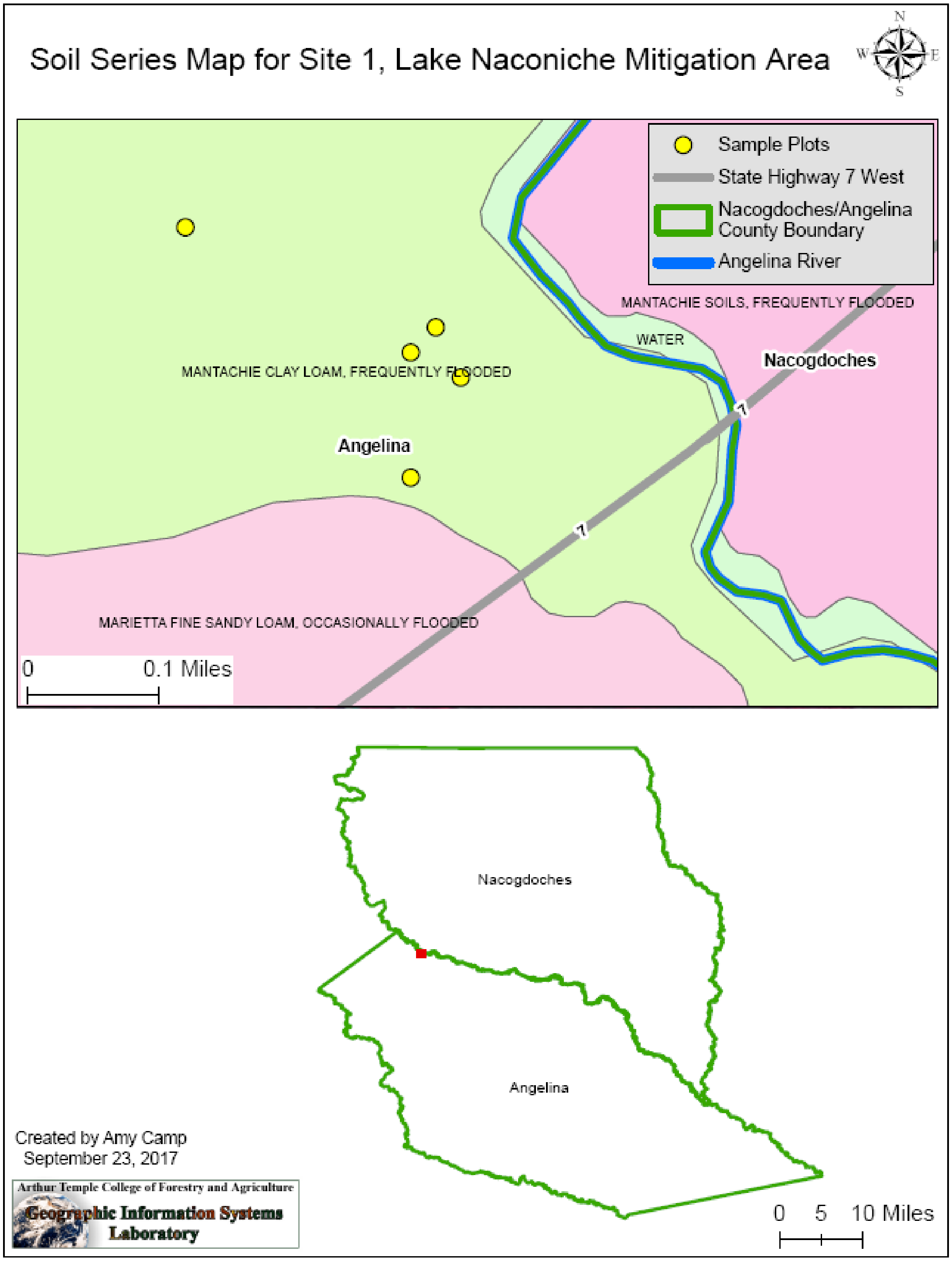



Figure 25. Soil series map for Site 1, Lake Naconiche Mitigation Area in Angelina County, TX, and subsequent sampling plots.

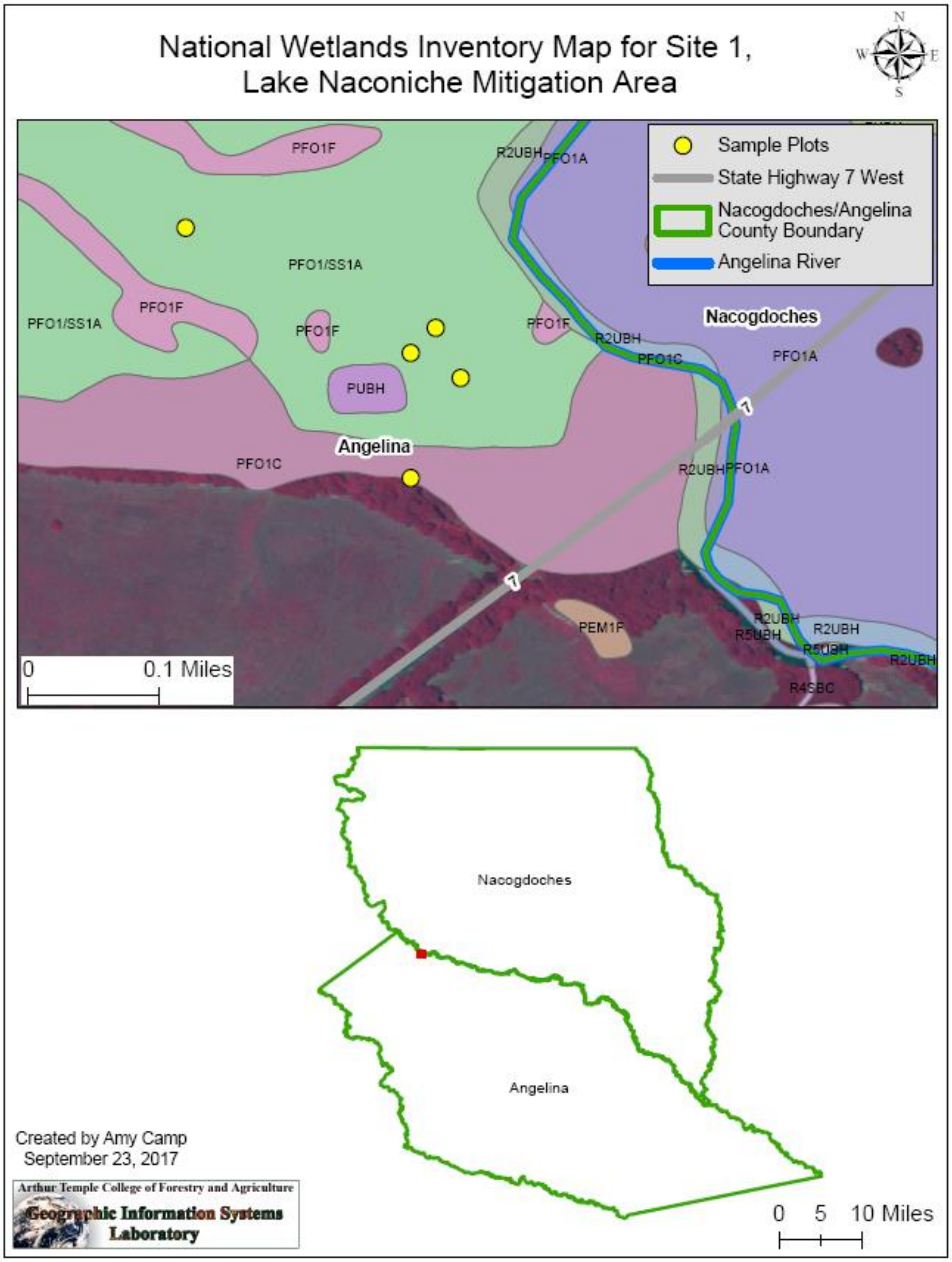



Figure 26. National Wetlands Inventory Map for Site 1, Lake Naconiche Mitigation Area in Angelina County, TX, and subsequent sampling plots.

Stephen F. Austin Experimental Forest

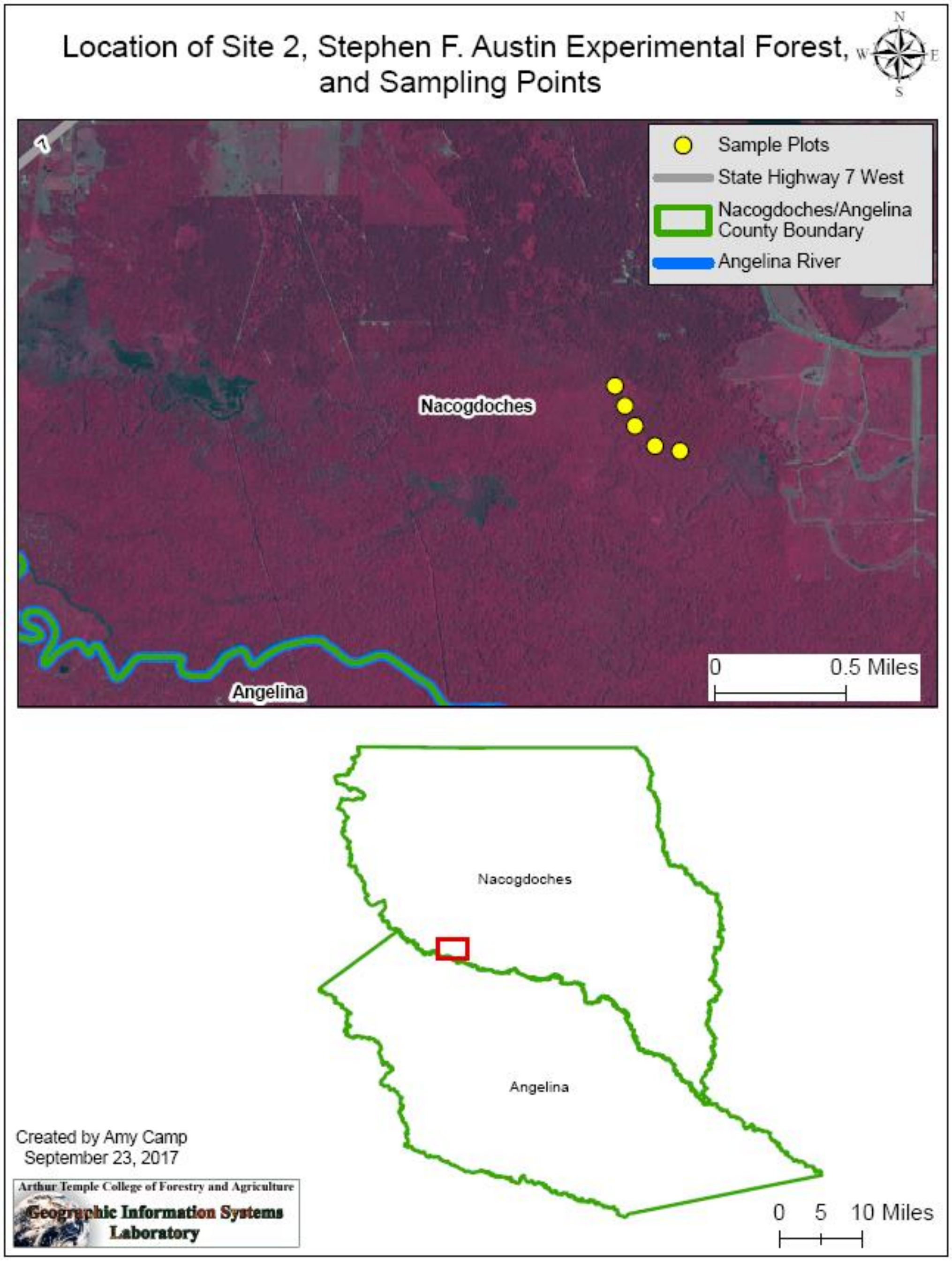



Figure 27. Location of Site 2, Stephen F. Austin Experimental Forest in Nacogdoches County, TX, and subsequent sampling plots.

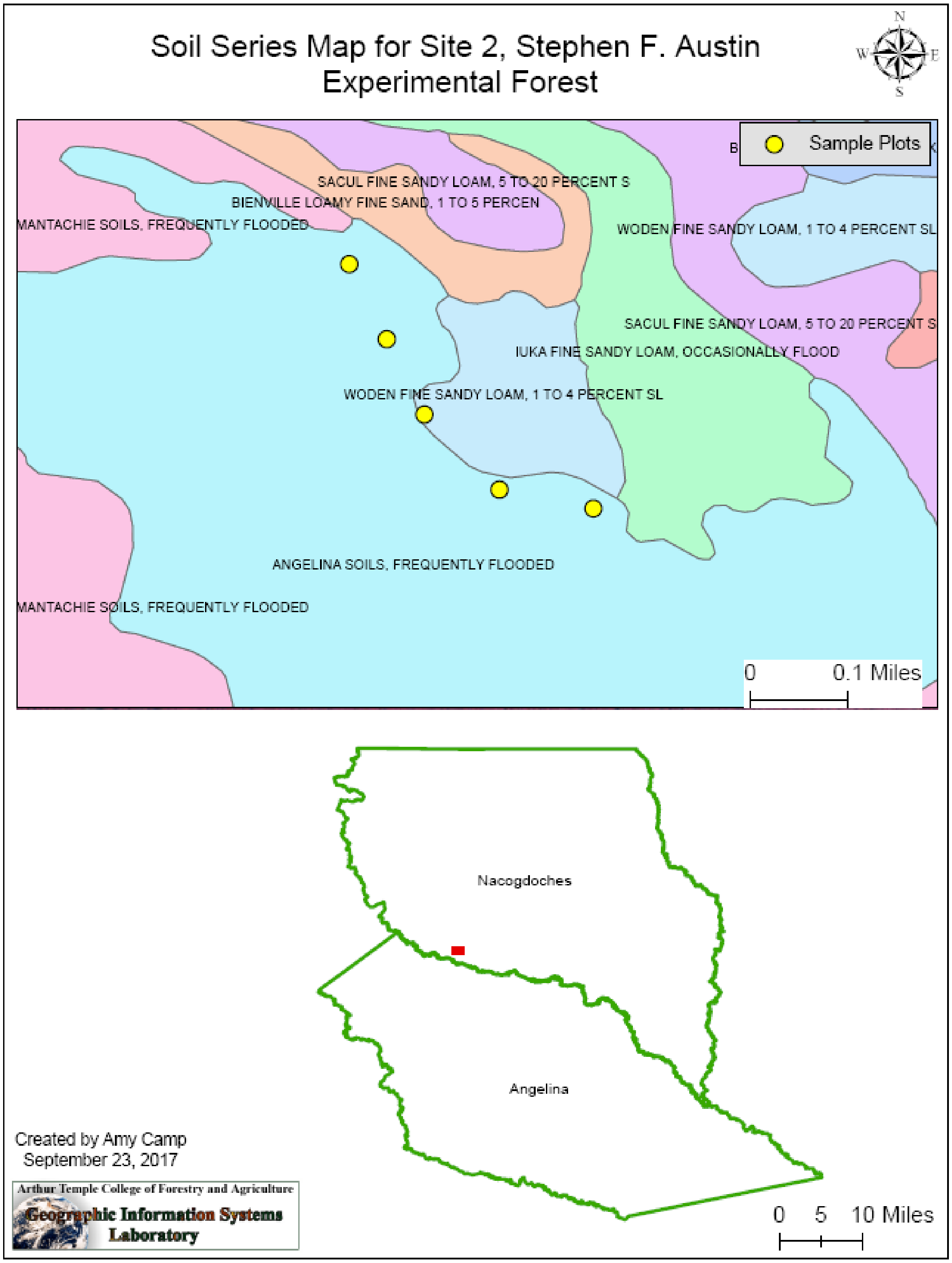



Figure 28. Soil series map for Site 2, Stephen F. Austin Experimental Forest in Nacogdoches County, TX, and subsequent sampling plots.

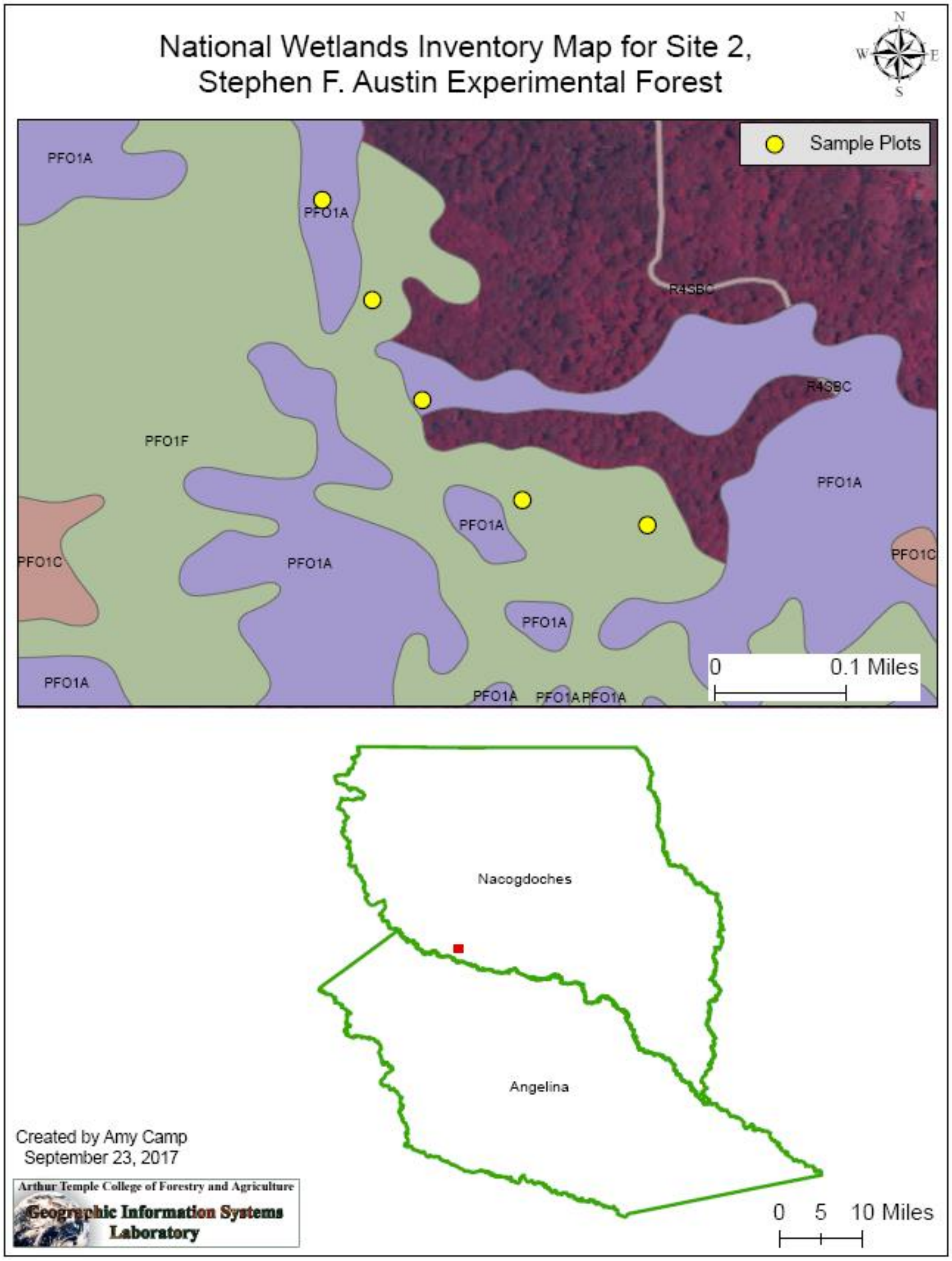



Figure 29. National Wetlands Inventory Map for Site 2, Stephen F. Austin Experimental Forest in Nacogdoches County, TX, and subsequent sampling plots.

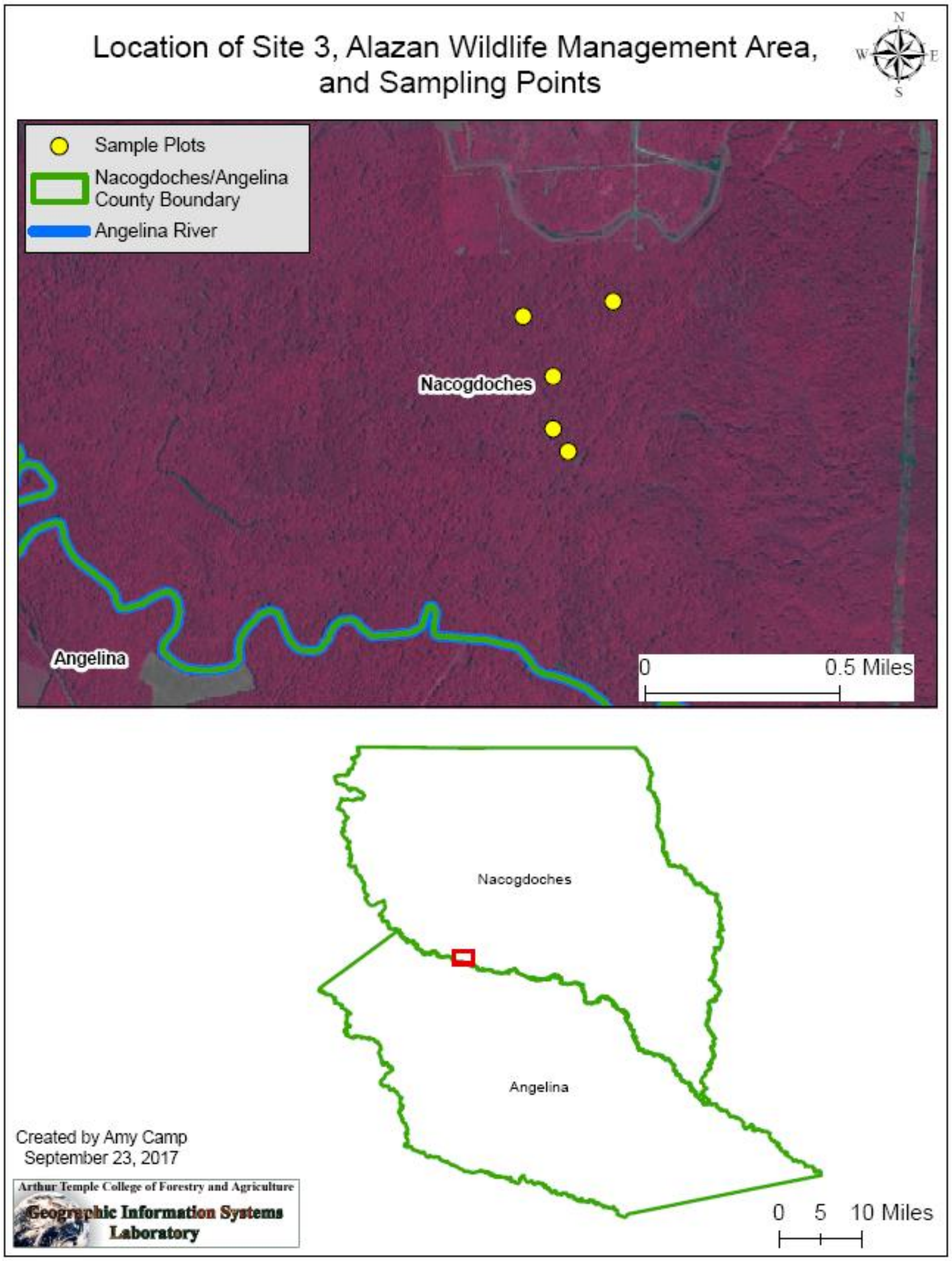



Figure 30. Location of Site 3, Alazan Wildlife Management Area in Nacogdoches County, TX, and subsequent sampling plots.

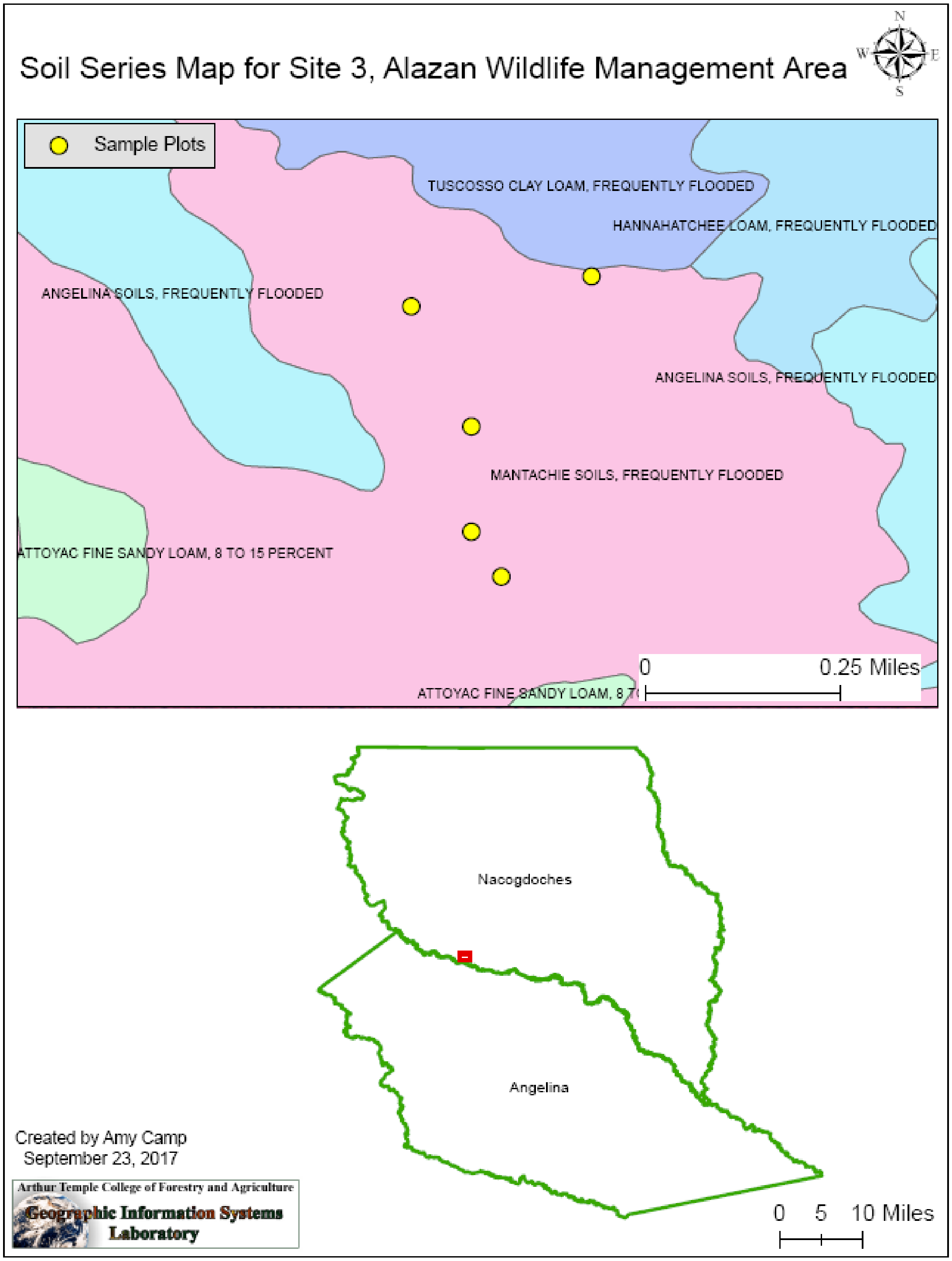



Figure 31. Soil series map for Site 3, Alazan Wildlife Management Area in Nacogdoches County, TX, and subsequent sampling plots.

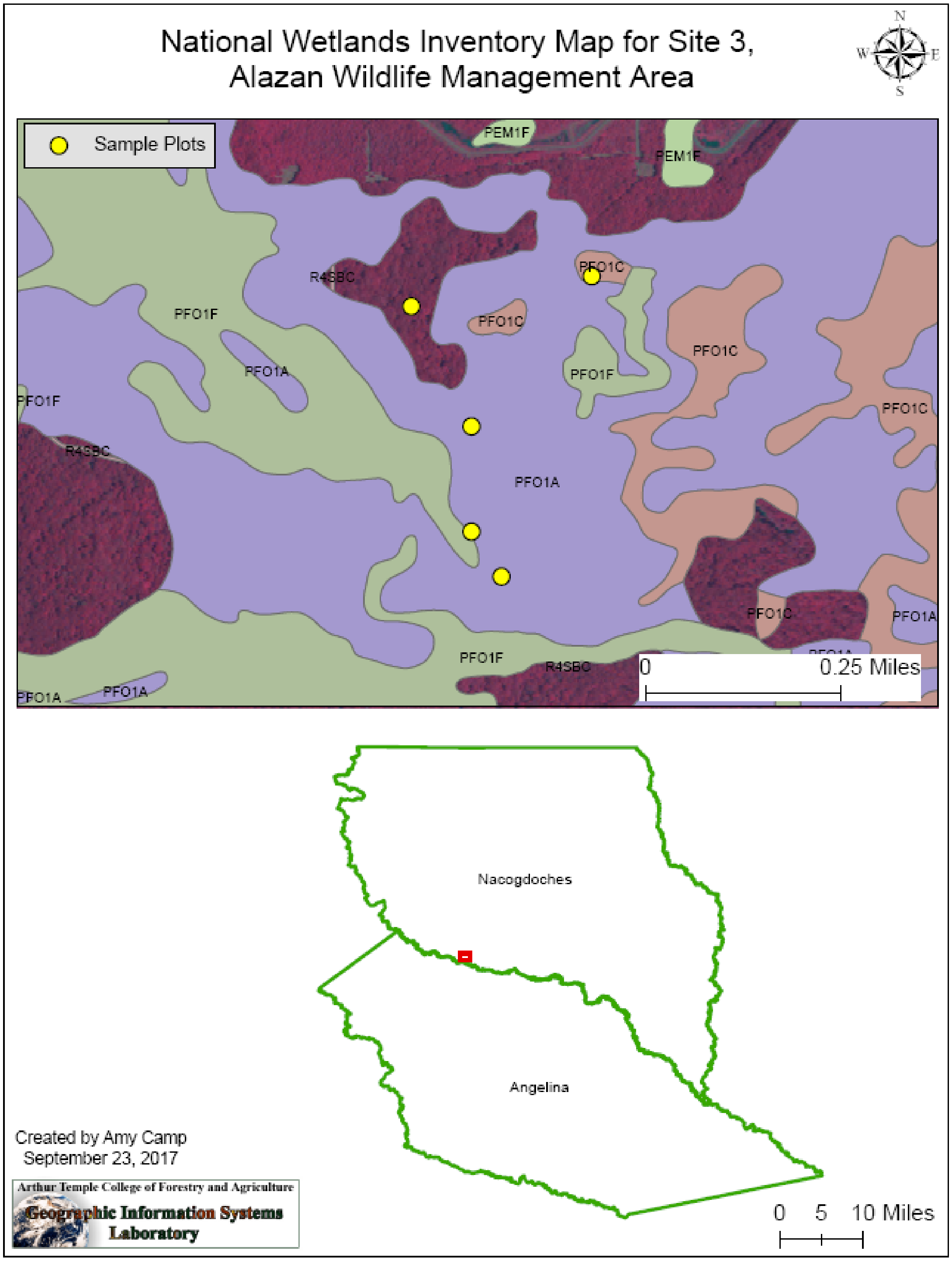



Figure 32. National Wetlands Inventory Map for Site 3, Alazan Wildlife Management Area in Nacogdoches County, TX, and subsequent sampling plots.

Boggy Slough Conservation Area

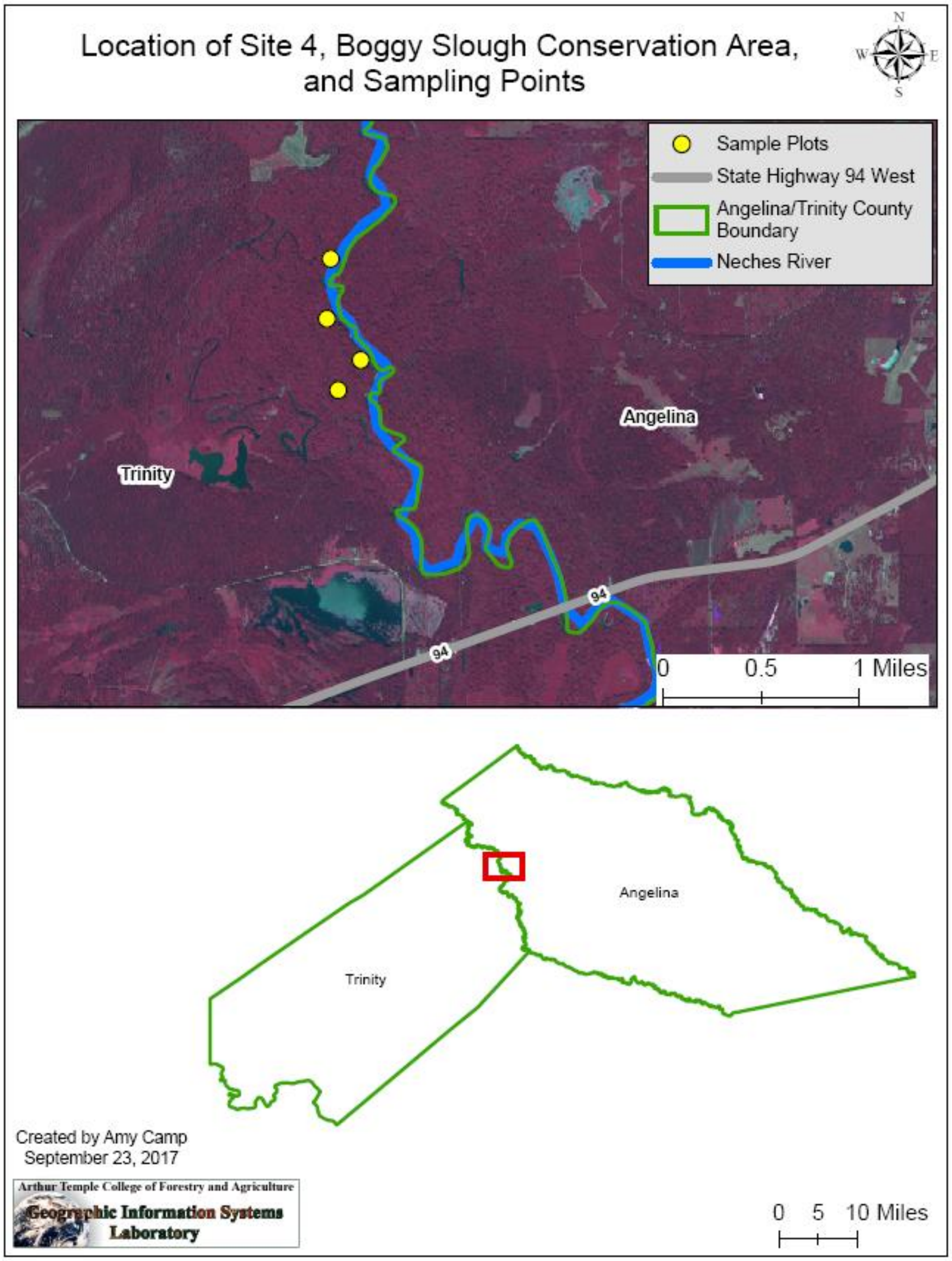



Figure 33. Location of Site 4, Boggy Slough Conservation Area, and sampling plots.

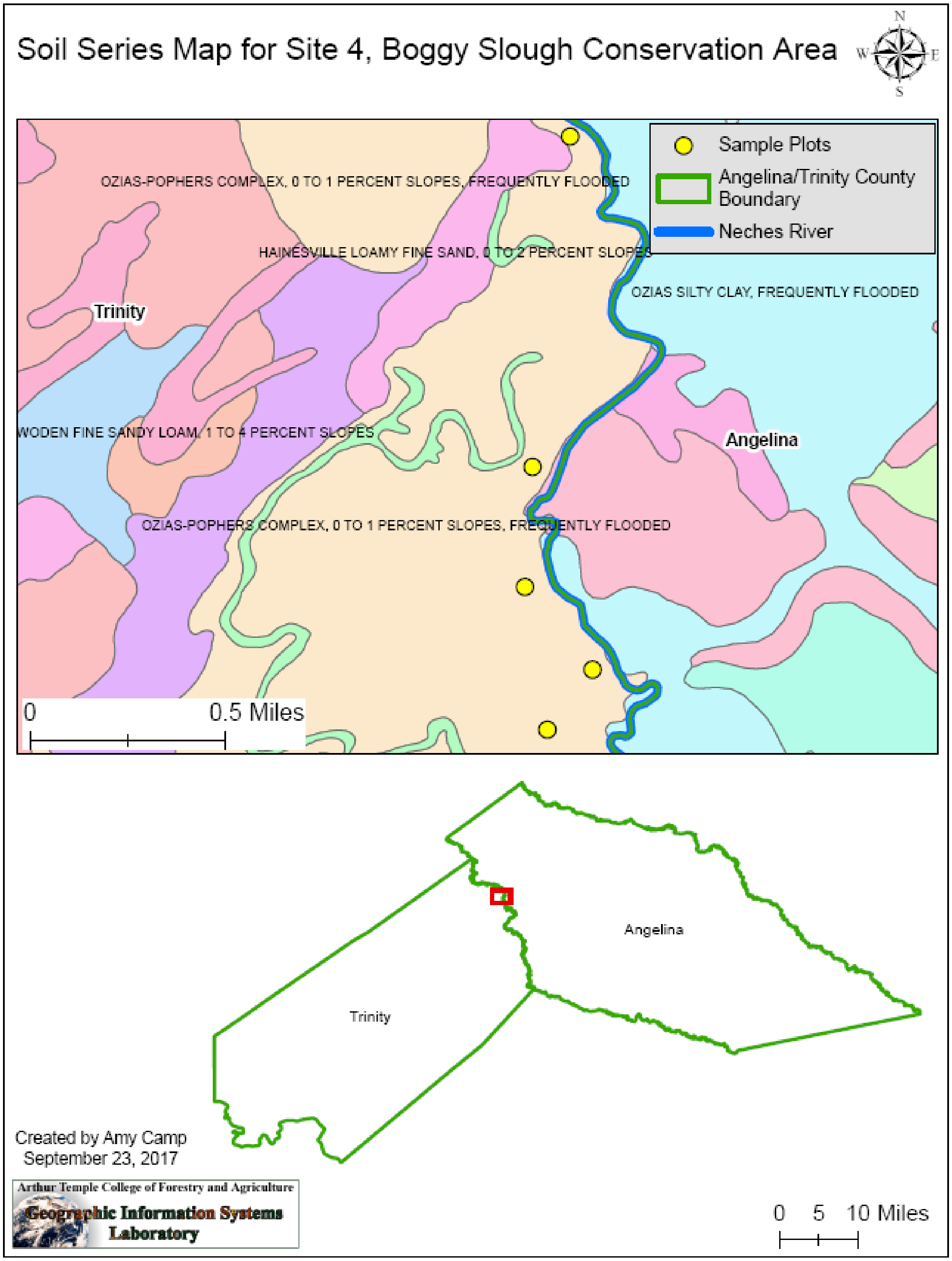



Figure 34. Soil series map for Site 4, Boggy Slough Conservation Area.

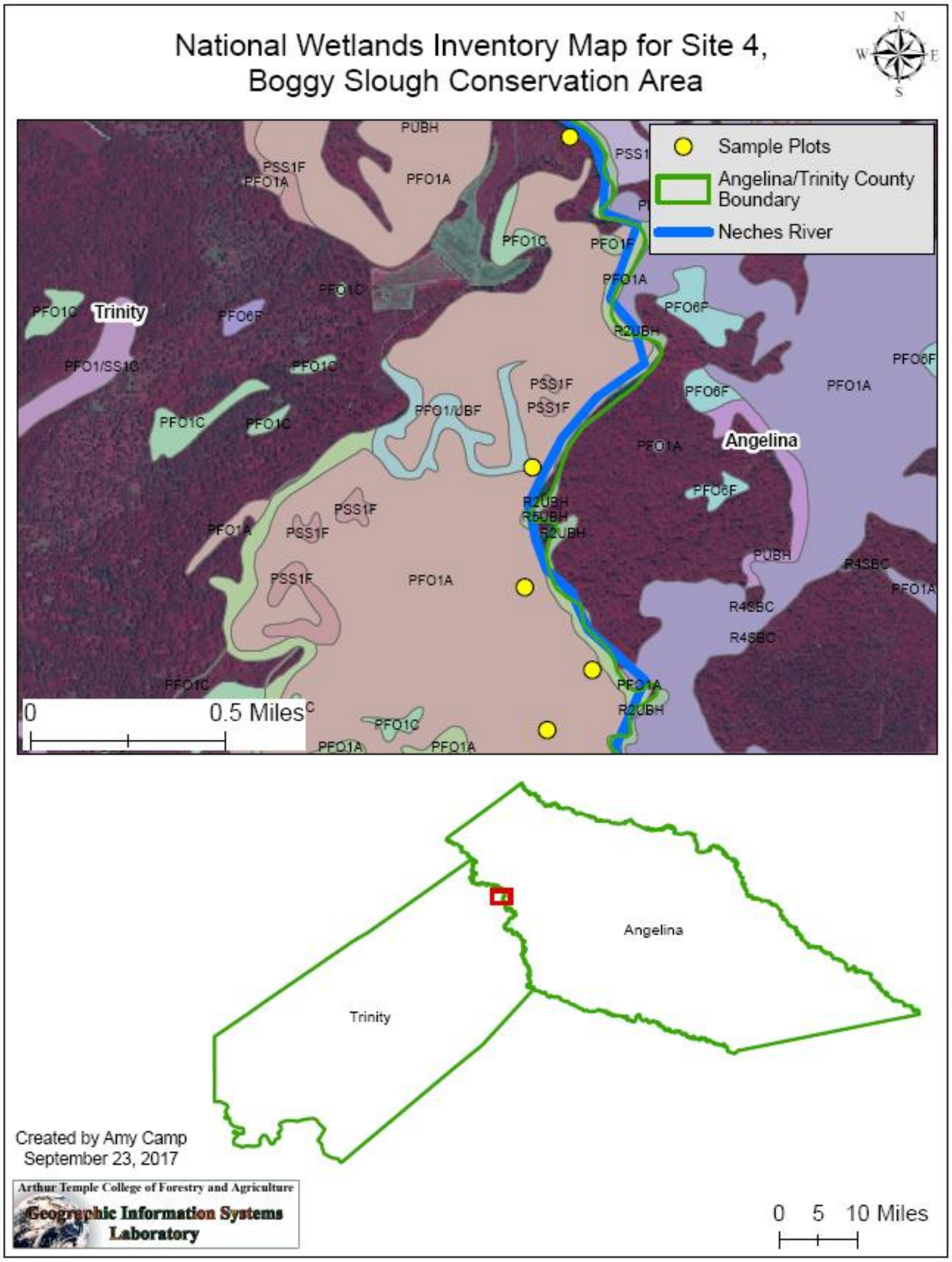



Figure 35. National Wetlands Inventory Map for Site 4, Boggy Slough Conservation Area.

Sacul, TX

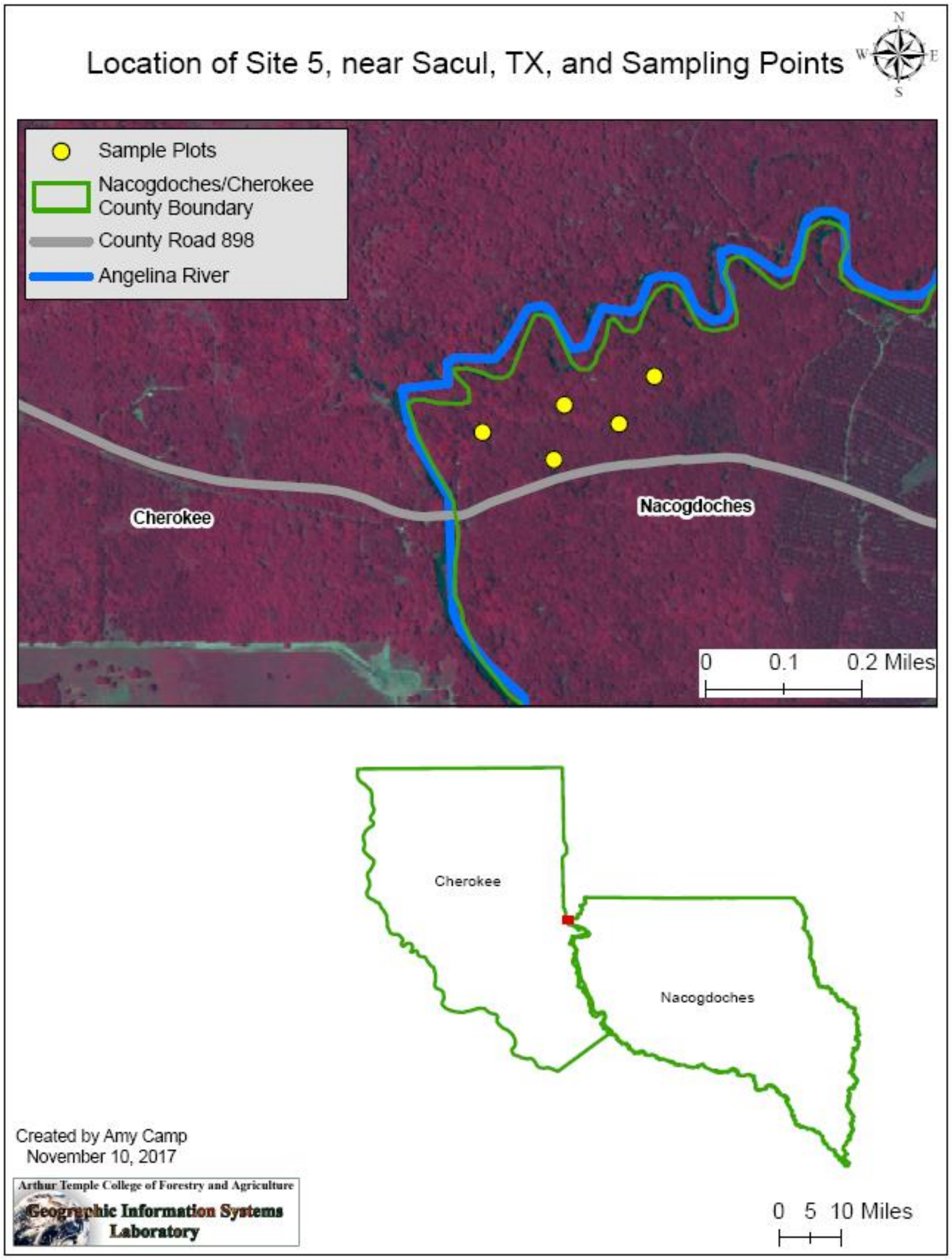



Figure 36. Location of Site 5, near Sacul, TX, in Nacogdoches County and subsequent sampling plots.

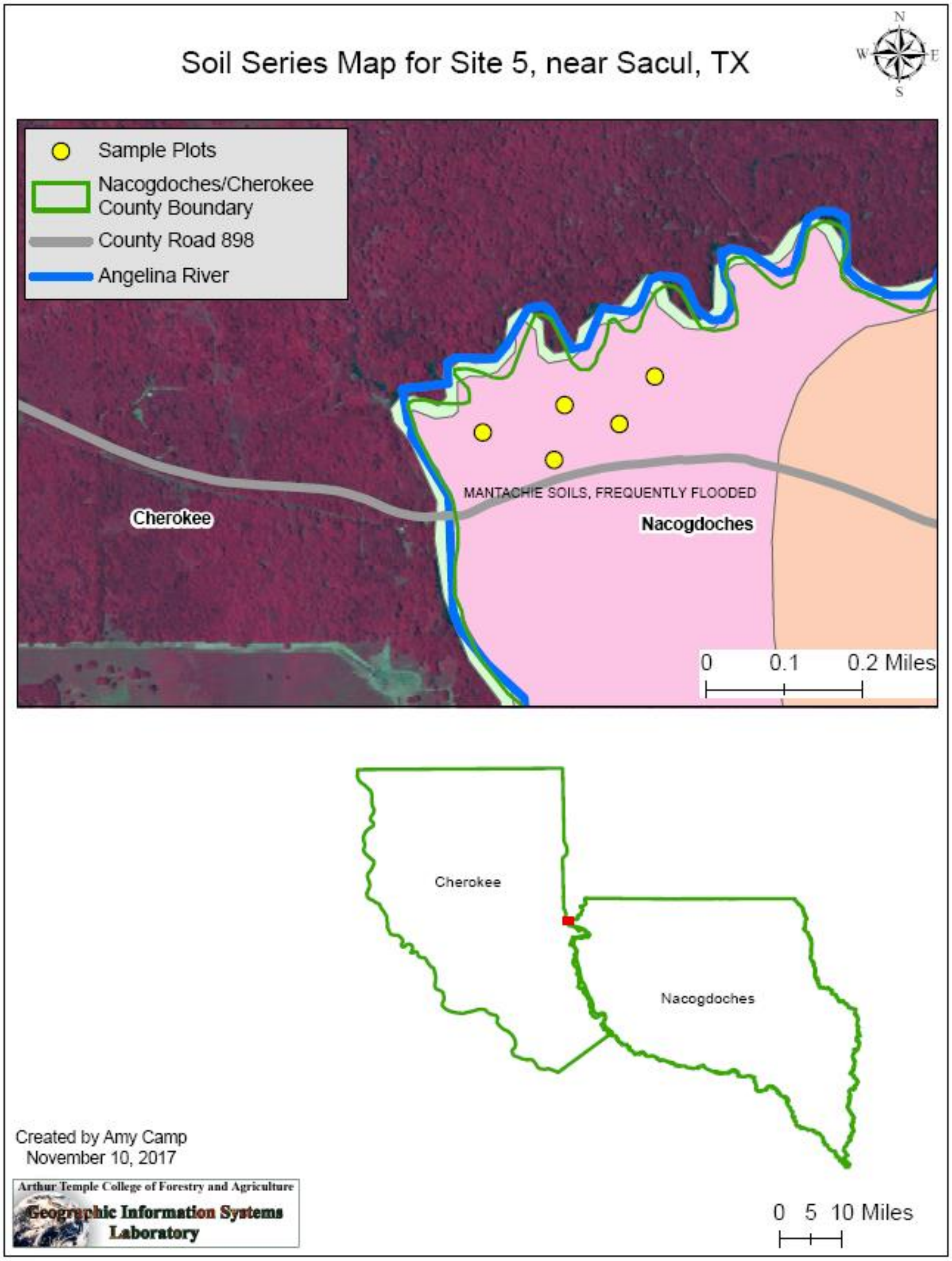



Figure 37. Soil series map for Site 5 near Sacul, TX, in Nacogdoches County and subsequent sampling plots.

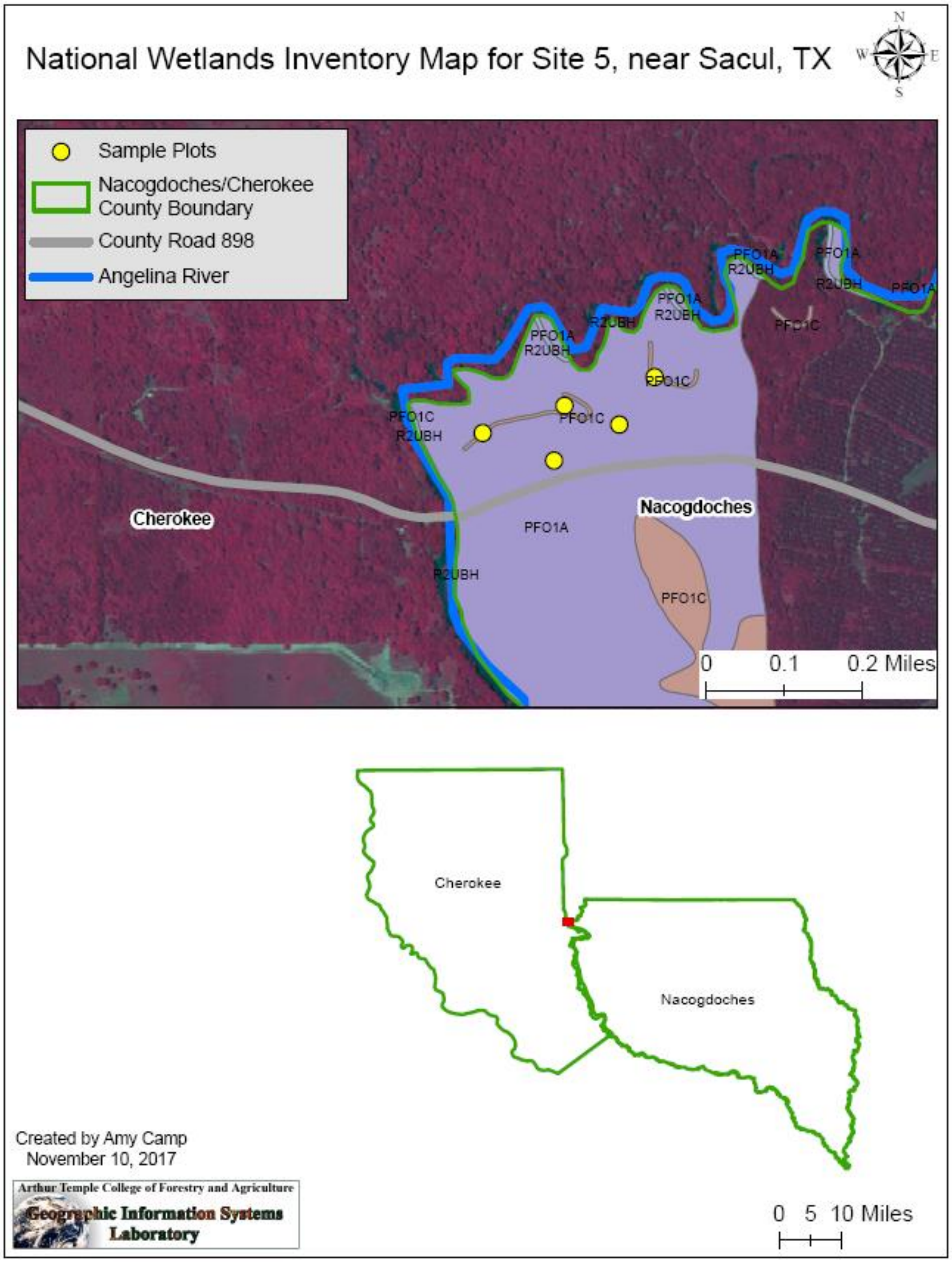



Figure 38. National Wetlands Inventory Map for Site 5 near Sacul, TX, in Nacogdoches County and subsequent sampling plots.

Determination

Lake Naconiche Mitigation Area

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Lake Naconiche Mitigation Area City/County: Angelina County Sampling Date: 03/15/2017

Applicant/Owner: Nacogdoches County State: TX Sampling Point: 1

Investigator(s): A. Camp, W. Johnson, S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.48583333 Long: -94.82694444 Datum: WGS 84

Soil Map Unit Name: Mantachie clay loam, frequently flooded NWI classification: PFO1/SS1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? Yes X No ___ | **Is the Sampled Area within a Wetland?** | **Yes** X **No** ___ |
| Hydric Soil Present? Yes X No ___ | | |
| Wetland Hydrology Present? Yes X No ___ | | |

Remarks:

Former river channels inundated throughout the site.

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☑ Water Marks (B1)
- ☑ Sediment Deposits (B2)
- ☑ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☑ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ______

**Wetland Hydrology Present? Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Watermarks very prominent on trees. Light sediment deposits about 3 feet high on tree trunks. Drift deposits very common throughout the site.

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Figure 39a. Site information and hydrology indicators for Site 1, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata)** – Use scientific names of plants. Sampling Point: 1

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 15 | Y | OBL |
| 2. Quercus nigra | 5 | Y | FAC |
| 3. Ulmus americana | 5 | Y | FAC |
| 4. Liquidambar styraciflua | 5 | Y | FAC |
| 5. Prunus serotina | 5 | Y | FACU |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 35 = Total Cover | | |
| 50% of total cover: 17.5 | 20% of total cover: 7 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Liquidambar styraciflua | 5 | Y | FAC |
| 2. Quercus phellos | 2 | Y | FACW |
| 3. Ulmus americana | 2 | Y | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 9 = Total Cover | | |
| 50% of total cover: 4.5 | 20% of total cover: 1.8 | | |

| Herb Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus phellos | 15 | Y | FACW |
| 2. Quercus lyrata | 5 | N | OBL |
| 3. Liquidambar styraciflua | 5 | N | FAC |
| 4. Prunus serotina | 2 | N | FACU |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 27 = Total Cover | | |
| 50% of total cover: 13.5 | 20% of total cover: 5.4 | | |

| Woody Vine Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 0 = Total Cover | | |
| 50% of total cover: 0 | 20% of total cover: 0 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 89% (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 20 | x 1 = | 20 |
| FACW species | 17 | x 2 = | 34 |
| FAC species | 27 | x 3 = | 81 |
| FACU species | 7 | x 4 = | 28 |
| UPL species | 0 | x 5 = | 0 |
| Column Totals: | 71 (A) | | 163 (B) |

Prevalence Index = B/A = 2.3

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree –** Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub** – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb –** All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine –** All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

Hypertrophied lenticels and fluting were readily observed in tree stratum.

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Figure 39b. Vegetation cover by strata and morphological adaptations for Site 1, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 1

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 2.5-0 | N/A | | | | | | | O horizon |
| 0-8 | 5 YR 4/3 | 100 | | | | | sandy clay loam | A horizon |
| 8- | 5 YR 5/1 | 60 | 5 YR 5/8 | 40 | C | PL | sandy clay loam | Bg1 horizon |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present? Yes** X **No** ______

Remarks:

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Figure 39c. Soil indicators for Site 1, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Lake Naconiche Mitigation Area City/County: Angelina Sampling Date: 03/15/2017

Applicant/Owner: Nacogdoches County State: TX Sampling Point: 4

Investigator(s): A. Camp, W. Johnson, S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.48750000 Long: -94.82666667 Datum: WGS84

Soil Map Unit Name: Mantachie clay loam, frequently flooded NWI classification: PFO1C

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ______ | Is the Sampled Area within a Wetland? | Yes X No ______ |
| Hydric Soil Present? | Yes X No ______ | | |
| Wetland Hydrology Present? | Yes X No ______ | | |

Remarks:

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☑ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☑ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

| | | | | |
|---|---|---|---|---|
| Surface Water Present? | Yes ______ | No X | Depth (inches): ______ | |
| Water Table Present? | Yes ______ | No X | Depth (inches): ______ | |
| Saturation Present? (includes capillary fringe) | Yes ______ | No X | Depth (inches): ______ | **Wetland Hydrology Present? Yes X No ______** |

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Prominent watermarks and drift deposits within the area.

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Figure 40a. Site information and hydrology indicators for Site 1, plot 4, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants. Sampling Point: 4

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus phellos | 20 | Y | FACW |
| 2. Liquidambar styraciflua | 20 | Y | FAC |
| 3. Carpinus caroliniana | 20 | Y | FAC |
| 4. Quercus lyrata | 10 | N | OBL |
| 5. Nyssa sylvatica | 2 | N | FAC |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 72 = Total Cover | | |
| 50% of total cover: 36 | 20% of total cover: 14.4 | | |
| **Sapling/Shrub Stratum** (Plot size: 1/10 acre) | | | |
| 1. Ilex vomitoria | 10 | Y | FAC |
| 2. Carpinus caroliniana | 10 | Y | FAC |
| 3. Liquidambar styraciflua | 5 | Y | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 25 = Total Cover | | |
| 50% of total cover: 12.5 | 20% of total cover: 5 | | |
| **Herb Stratum** (Plot size: 1/10 acre) | | | |
| 1. Quercus lyrata | 5 | Y | OBL |
| 2. Liquidambar styraciflua | 2 | Y | FAC |
| 3. Carpinus caroliniana | 2 | Y | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 9 = Total Cover | | |
| 50% of total cover: 4.5 | 20% of total cover: 1.8 | | |
| **Woody Vine Stratum** (Plot size: 1/10 acre) | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 0 = Total Cover | | |
| 50% of total cover: 0 | 20% of total cover: 0 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 9 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 15 | x 1 = 15 |
| FACW species | 20 | x 2 = 40 |
| FAC species | 71 | x 3 = 213 |
| FACU species | 0 | x 4 = 0 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 106 (A) | 268 (B) |

Prevalence Index = B/A = 2.53

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub –** Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine –** All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

Buttressing and fluting observable in tree stratum.

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Figure 40b. Vegetation cover by strata and morphological adaptations for Site 1, plot 4, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 4

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 2-0 | N/A | | | | | | | O horizon |
| 0-10 | 7.5 YR 4/3 | 100 | | | | | sandy clay loam | A horizon |
| 10- | 7.5 YR 5/2 | 65 | 7.5 YR 4/6 | 35 | C | PL | sandy clay loam | Bg1 horizon |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ____________

Depth (inches): ____________

**Hydric Soil Present?** Yes X No ____

Remarks:

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Figure 40c. Soil indicators for Site 1, plot 4, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

Figure 41. Watermarks, a primary indicator of wetland hydrology, observed on Site 1.

Figure 42. Reduced matrix, hydric soil indicator (F3), observed on Site 1 (left).

Figure 43. Drift lines, a primary indicator of wetland hydrology, observed on Site 1. (right)

Stephen F. Austin Experimental Forest

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Stephen F. Austin Experimental Forest City/County: Nacogdoches Sampling Date: 04/13/2017

Applicant/Owner: US Forest Service State: TX Sampling Point: 1

Investigator(s): A. Camp & S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.49527778 Long: -94.76444444 Datum: WGS84

Soil Map Unit Name: Angelina soils, frequently flooded NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ______ | **Is the Sampled Area within a Wetland?** **Yes** X **No** ______ |
| Hydric Soil Present? | Yes X No ______ | |
| Wetland Hydrology Present? | Yes X No ______ | |

Remarks:

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [x] High Water Table (A2)
- [x] Saturation (A3)
- [x] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [x] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [x] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] Marl Deposits (B15) **(LRR U)**
- [ ] Hydrogen Sulfide Odor (C1)
- [x] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [ ] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [x] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [ ] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] FAC-Neutral Test (D5)
- [ ] Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes X No ______ Depth (inches): 6.5

Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 0

**Wetland Hydrology Present? Yes** X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

The area was surrounded by shallow PFO1F sloughs.

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 44a. Site information and hydrology indicators for Site 2, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants.

Sampling Point: 1

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus phellos | 60 | Y | FACW |
| 2. Liquidambar styraciflua | 25 | Y | FAC |
| 3. Acer rubrum | 10 | N | FAC |
| 4. Cornus florida | 5 | N | FACU |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 100 = Total Cover | | |
| 50% of total cover: 50 | 20% of total cover: 20 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Triadica sebifera | 5 | Y | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 5 = Total Cover | | |
| 50% of total cover: 2.5 | 20% of total cover: 1 | | |

| Herb Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus phellos | 30 | Y | FACW |
| 2. Liquidambar styraciflua | 5 | N | FAC |
| 3. Triadica sebifera | 3 | N | FAC |
| 4. Acer rubrum | 3 | N | FAC |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 41 = Total Cover | | |
| 50% of total cover: 20.5 | 20% of total cover: 8.2 | | |

| Woody Vine Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 0 = Total Cover | | |
| 50% of total cover: 0 | 20% of total cover: 0 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 0 | x 1 = 0 |
| FACW species | 90 | x 2 = 180 |
| FAC species | 51 | x 3 = 153 |
| FACU species | 5 | x 4 = 20 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 146 (A) | 353 (B) |

Prevalence Index = B/A = 2.42

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree –** Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub –** Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb –** All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine –** All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

Most trees exhibited fluting. Small amount of surface roots observed.

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 44b. Vegetation cover by strata and morphological adaptations for Site 2, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 1

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth | Matrix | | Redox Features | | | | | |
|---|---|---|---|---|---|---|---|---|
| (inches) | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | Texture | Remarks |
| 2-0 | N/A | | | | | | | O horizon |
| 0-6.5 | 10 YR 4/2 | 100 | | | | | sandy clay loam | A1g horizon |
| 6.5- | 10 YR 5/2 | 75 | 5 YR 3/4 | 25 | C | PL | clay loam | C1g |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- [ ] Histosol (A1)
- [ ] Histic Epipedon (A2)
- [ ] Black Histic (A3)
- [ ] Hydrogen Sulfide (A4)
- [ ] Stratified Layers (A5)
- [ ] Organic Bodies (A6) **(LRR P, T, U)**
- [ ] 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- [ ] Muck Presence (A8) **(LRR U)**
- [ ] 1 cm Muck (A9) **(LRR P, T)**
- [ ] Depleted Below Dark Surface (A11)
- [ ] Thick Dark Surface (A12)
- [ ] Coast Prairie Redox (A16) **(MLRA 150A)**
- [ ] Sandy Mucky Mineral (S1) **(LRR O, S)**
- [ ] Sandy Gleyed Matrix (S4)
- [ ] Sandy Redox (S5)
- [ ] Stripped Matrix (S6)
- [ ] Dark Surface (S7) **(LRR P, S, T, U)**
- [ ] Polyvalue Below Surface (S8) **(LRR S, T, U)**
- [ ] Thin Dark Surface (S9) **(LRR S, T, U)**
- [ ] Loamy Mucky Mineral (F1) **(LRR O)**
- [ ] Loamy Gleyed Matrix (F2)
- [x] Depleted Matrix (F3)
- [ ] Redox Dark Surface (F6)
- [ ] Depleted Dark Surface (F7)
- [ ] Redox Depressions (F8)
- [ ] Marl (F10) **(LRR U)**
- [ ] Depleted Ochric (F11) **(MLRA 151)**
- [ ] Iron-Manganese Masses (F12) **(LRR O, P, T)**
- [ ] Umbric Surface (F13) **(LRR P, T, U)**
- [ ] Delta Ochric (F17) **(MLRA 151)**
- [ ] Reduced Vertic (F18) **(MLRA 150A, 150B)**
- [ ] Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- [ ] 1 cm Muck (A9) **(LRR O)**
- [ ] 2 cm Muck (A10) **(LRR S)**
- [ ] Reduced Vertic (F18) **(outside MLRA 150A,B)**
- [ ] Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- [ ] Red Parent Material (TF2)
- [ ] Very Shallow Dark Surface (TF12)
- [ ] Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______________

Depth (inches): ______________

**Hydric Soil Present?** **Yes** X **No** ______

Remarks:

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Figure 44c. Soil indicators for Site 2, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Stephen F. Austin Experimental Forest City/County: Nacogdoches Sampling Date: 04/13/2017

Applicant/Owner: US Forest Service State: TX Sampling Point: 5

Investigator(s): A. Camp & S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.49166667 Long: -94.76083333 Datum: NAD83

Soil Map Unit Name: Angelina soils, frequently flooded NWI classification: PFO1F

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? Yes X No ______ | | **Is the Sampled Area within a Wetland?** **Yes** X **No** ______ |
| Hydric Soil Present? Yes X No ______ | | |
| Wetland Hydrology Present? Yes X No ______ | | |

Remarks:

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

| | |
|---|---|
| ☐ Surface Water (A1) | ☐ Aquatic Fauna (B13) |
| ☑ High Water Table (A2) | ☐ Marl Deposits (B15) **(LRR U)** |
| ☑ Saturation (A3) | ☐ Hydrogen Sulfide Odor (C1) |
| ☑ Water Marks (B1) | ☑ Oxidized Rhizospheres along Living Roots (C3) |
| ☐ Sediment Deposits (B2) | ☐ Presence of Reduced Iron (C4) |
| ☑ Drift Deposits (B3) | ☐ Recent Iron Reduction in Tilled Soils (C6) |
| ☐ Algal Mat or Crust (B4) | ☐ Thin Muck Surface (C7) |
| ☐ Iron Deposits (B5) | ☐ Other (Explain in Remarks) |
| ☐ Inundation Visible on Aerial Imagery (B7) | |
| ☐ Water-Stained Leaves (B9) | |

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☑ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes X No ______ Depth (inches): 8

Saturation Present? (includes capillary fringe) Yes X No ______ Depth (inches): 0

**Wetland Hydrology Present? Yes** X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Water quickly filled in soil pit. Readily observable drift deposits

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Figure 45a. Site information and hydrology indicators for Site 2, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants.

Sampling Point: 5

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus nigra | 40 | Y | FAC |
| 2. Liquidambar styraciflua | 30 | Y | FAC |
| 3. Quercus phellos | 10 | N | FACW |
| 4. Acer rubrum | 10 | N | FAC |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 90 = Total Cover | | |
| 50% of total cover: 45 | 20% of total cover: 18 | | |
| **Sapling/Shrub Stratum** (Plot size: 1/10 acre) | | | |
| 1. Acer rubrum | 40 | Y | FAC |
| 2. Triadica sebifera | 5 | N | FAC |
| 3. Ilex vomitoria | 2 | N | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 47 = Total Cover | | |
| 50% of total cover: 23.5 | 20% of total cover: 9.4 | | |
| **Herb Stratum** (Plot size: 1/10 acre) | | | |
| 1. Acer rubrum | 10 | Y | FAC |
| 2. Quercus nigra | 5 | Y | FAC |
| 3. Triadica sebifera | 5 | Y | FAC |
| 4. Quercus phellos | 2 | N | FACW |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 22 = Total Cover | | |
| 50% of total cover: 11 | 20% of total cover: 4.4 | | |
| **Woody Vine Stratum** (Plot size: 1/10 acre) | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 0 = Total Cover | | |
| 50% of total cover: 0 | 20% of total cover: 0 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 0 | x 1 = 0 |
| FACW species | 12 | x 2 = 24 |
| FAC species | 147 | x 3 = 441 |
| FACU species | 0 | x 4 = 0 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 159 (A) | 465 (B) |

Prevalence Index = B/A = 2.92

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub** – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

Fluting and buttressing present on trees.

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Figure 45b. Vegetation cover by strata and morphological adaptations for Site 2, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL**

Sampling Point: 5

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1-0 | N/A | | | | | | | O horizon |
| 0-10 | 10 YR 4/1 | 51 | 2.5 YR 4/6 | 49 | C | PL | sandy clay loam | |
| 10- | 10 YR 6/1 | 100 | | | | | clay loam | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- [ ] Histosol (A1)
- [ ] Histic Epipedon (A2)
- [ ] Black Histic (A3)
- [ ] Hydrogen Sulfide (A4)
- [ ] Stratified Layers (A5)
- [ ] Organic Bodies (A6) **(LRR P, T, U)**
- [ ] 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- [ ] Muck Presence (A8) **(LRR U)**
- [ ] 1 cm Muck (A9) **(LRR P, T)**
- [ ] Depleted Below Dark Surface (A11)
- [ ] Thick Dark Surface (A12)
- [ ] Coast Prairie Redox (A16) **(MLRA 150A)**
- [ ] Sandy Mucky Mineral (S1) **(LRR O, S)**
- [ ] Sandy Gleyed Matrix (S4)
- [ ] Sandy Redox (S5)
- [ ] Stripped Matrix (S6)
- [ ] Dark Surface (S7) **(LRR P, S, T, U)**
- [ ] Polyvalue Below Surface (S8) **(LRR S, T, U)**
- [ ] Thin Dark Surface (S9) **(LRR S, T, U)**
- [ ] Loamy Mucky Mineral (F1) **(LRR O)**
- [ ] Loamy Gleyed Matrix (F2)
- [x] Depleted Matrix (F3)
- [ ] Redox Dark Surface (F6)
- [ ] Depleted Dark Surface (F7)
- [ ] Redox Depressions (F8)
- [ ] Marl (F10) **(LRR U)**
- [ ] Depleted Ochric (F11) **(MLRA 151)**
- [ ] Iron-Manganese Masses (F12) **(LRR O, P, T)**
- [ ] Umbric Surface (F13) **(LRR P, T, U)**
- [ ] Delta Ochric (F17) **(MLRA 151)**
- [ ] Reduced Vertic (F18) **(MLRA 150A, 150B)**
- [ ] Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- [ ] 1 cm Muck (A9) **(LRR O)**
- [ ] 2 cm Muck (A10) **(LRR S)**
- [ ] Reduced Vertic (F18) **(outside MLRA 150A,B)**
- [ ] Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- [ ] Red Parent Material (TF2)
- [ ] Very Shallow Dark Surface (TF12)
- [ ] Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present?** Yes X No ____

Remarks:

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 45c. Soil indicators for Site 2, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010

 

Figure 46. Fluting, a morphological adaptation, on a tree at Site 2 (left).

Figure 47. High water table (A2), a primary indicator of wetland hydrology, observed in a soil pit on Site 2 (right).

 

Figure 48. Reduced matrix, hydric soil indicator (F3), observed on Site 2 (left).

Figure 49. Fluting, a morphological adaptation, on a tree at Site 2 (right).

Alazan Wildlife Management Area

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Alazan WMA City/County: Nacogdoches Sampling Date: 04/17/2017

Applicant/Owner: Texas Parks & Wildlife Department State: TX Sampling Point: 1

Investigator(s): A. Camp & S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.47722222 Long: -94.75027778 Datum: WGS84

Soil Map Unit Name: Mantachie soils, frequently flooded NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ______ | **Is the Sampled Area within a Wetland?** | **Yes** X **No** ______ |
| Hydric Soil Present? | Yes X No ______ | | |
| Wetland Hydrology Present? | Yes X No ______ | | |

Remarks:

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☑ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☑ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☑ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ______ No X | Depth (inches): ______ | |
| Water Table Present? | Yes X No ______ | Depth (inches): 10 | |
| Saturation Present? (includes capillary fringe) | Yes X No ______ | Depth (inches): 5 | **Wetland Hydrology Present? Yes** ______ **No** ______ |

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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Figure 50a. Site information and hydrology indicators for Site 3, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata)** – Use scientific names of plants. Sampling Point: 1

| Tree Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 30 | Y | OBL |
| 2. Quercus nigra | 15 | Y | FAC |
| 3. Ulmus americana | 5 | N | FAC |
| 4. Acer rubrum | 2 | N | FAC |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 52 | = Total Cover | |
| 50% of total cover: 26 | 20% of total cover: 10.4 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 35 | Y | OBL |
| 2. Triadica sebifera | 10 | N | FAC |
| 3. Quercus nigra | 5 | N | FAC |
| 4. Prunus serotina | 5 | N | FACU |
| 5. Carya aquatica | 2 | N | OBL |
| 6. Acer rubrum | 2 | N | FAC |
| 7. | | | |
| 8. | | | |
| | 59 | = Total Cover | |
| 50% of total cover: 29.5 | 20% of total cover: 11.8 | | |

| Herb Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 3 | Y | OBL |
| 2. Pinus taeda | 2 | Y | FAC |
| 3. Triadica sebifera | 2 | Y | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 7 | = Total Cover | |
| 50% of total cover: 3.5 | 20% of total cover: 1.2 | | |

| Woody Vine Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Ampelopsis arborea | 30 | Y | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 30 | = Total Cover | |
| 50% of total cover: 15 | 20% of total cover: 6 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| | Total % Cover of: | Multiply by: |
|---|---|---|
| OBL species | 70 | x 1 = 70 |
| FACW species | 0 | x 2 = 0 |
| FAC species | 73 | x 3 = 219 |
| FACU species | 5 | x 4 = 20 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 148 (A) | 309 (B) |

Prevalence Index = B/A = 2.09

**Hydrophytic Vegetation Indicators:**

☑ 1 - Rapid Test for Hydrophytic Vegetation

☑ 2 - Dominance Test is >50%

☑ 3 - Prevalence Index is ≤3.0[1]

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub** – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 50b. Vegetation cover by strata and morphological adaptations for Site 3, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 1

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth | Matrix | | Redox Features | | | | | |
|---|---|---|---|---|---|---|---|---|
| (inches) | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | Texture | Remarks |
| 2-0 | N/A | | | | | | | |
| 0-12 | 7.5 YR 4/2 | 60 | 2.5 YR 4/6 | 40 | C | PL | Sandy clay loam | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present?** Yes X No ______

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 50c. Soil indicators for Site 3, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

## WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Alazan WMA City/County: Nacogdoches Sampling Date: 04/17/2017

Applicant/Owner: Texas Parks & Wildlife Department State: TX Sampling Point: 5

Investigator(s): A. Camp & S. Singletary Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.48277778 Long: -94.74861111 Datum: WGS84

Soil Map Unit Name: Mantachie soils, frequently flooded NWI classification: PFO1C

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ______ | **Is the Sampled Area within a Wetland?** | **Yes** X **No** ______ |
| Hydric Soil Present? | Yes X No ______ | | |
| Wetland Hydrology Present? | Yes X No ______ | | |

Remarks:

### HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☑ High Water Table (A2)
- ☑ Saturation (A3)
- ☑ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☑ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☑ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

| | | | | |
|---|---|---|---|---|
| Surface Water Present? | Yes ______ | No X | Depth (inches): ______ | |
| Water Table Present? | Yes X | No ______ | Depth (inches): 6 | |
| Saturation Present? (includes capillary fringe) | Yes X | No ______ | Depth (inches): 0 | **Wetland Hydrology Present? Yes** X **No** ______ |

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 51a. Site information and hydrology indicators for Site 3, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata)** – Use scientific names of plants.

Sampling Point: 5

| Tree Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 30 | Y | OBL |
| 2. Acer rubrum | 15 | Y | FAC |
| 3. Quercus phellos | 10 | N | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 55 = Total Cover | | |
| 50% of total cover: 27.5 | 20% of total cover: 11 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Triadica sebifera | 5 | Y | FAC |
| 2. Nyssa sylvatica | 5 | Y | FAC |
| 3. Ilex vomitoria | 3 | Y | FAC |
| 4. Cornus florida | 1 | N | FACU |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 14 = Total Cover | | |
| 50% of total cover: 7 | 20% of total cover: 2.8 | | |

| Herb Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Saururus cernuus | 5 | Y | OBL |
| 2. Nyssa sylvatica | 2 | Y | FAC |
| 3. Brunnichia ovata | 2 | Y | FACW |
| 4. Liquidambar styraciflua | 1 | N | FAC |
| 5. Ilex vomitoria | 1 | N | FAC |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 11 = Total Cover | | |
| 50% of total cover: 5.5 | 20% of total cover: 1.2 | | |

| Woody Vine Stratum (Plot size: 1/10 ac) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | = Total Cover | | |
| 50% of total cover: | 20% of total cover: | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 35 | x 1 = 35 |
| FACW species | 12 | x 2 = 24 |
| FAC species | 32 | x 3 = 96 |
| FACU species | 1 | x 4 = 4 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 80 (A) | 159 (B) |

Prevalence Index = B/A = 1.99

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree –** Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub –** Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb –** All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 51b. Vegetation cover by strata and morphological adaptations for Site 3, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 5

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 2-0 | N/A | | | | | | | |
| 0-2 | 7.5 YR 3/1 | 85 | 2.5 YR 5/8 | 15 | C | PL | Loamy sand | |
| 2- | 7.5 YR 4/1 | 60 | 2.5 YR 4/8 | 40 | C | PL | Sandy clay loam | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Stratified Layers (A5)
☐ Organic Bodies (A6) **(LRR P, T, U)**
☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
☐ Muck Presence (A8) **(LRR U)**
☐ 1 cm Muck (A9) **(LRR P, T)**
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Coast Prairie Redox (A16) **(MLRA 150A)**
☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Dark Surface (S7) **(LRR P, S, T, U)**
☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
☐ Thin Dark Surface (S9) **(LRR S, T, U)**
☐ Loamy Mucky Mineral (F1) **(LRR O)**
☐ Loamy Gleyed Matrix (F2)
☑ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)
☐ Marl (F10) **(LRR U)**
☐ Depleted Ochric (F11) **(MLRA 151)**
☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
☐ Umbric Surface (F13) **(LRR P, T, U)**
☐ Delta Ochric (F17) **(MLRA 151)**
☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

☐ 1 cm Muck (A9) **(LRR O)**
☐ 2 cm Muck (A10) **(LRR S)**
☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ________

Depth (inches): ________

**Hydric Soil Present?** Yes X No ____

Remarks:

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Figure 51c. Soil indicators for Site 3, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

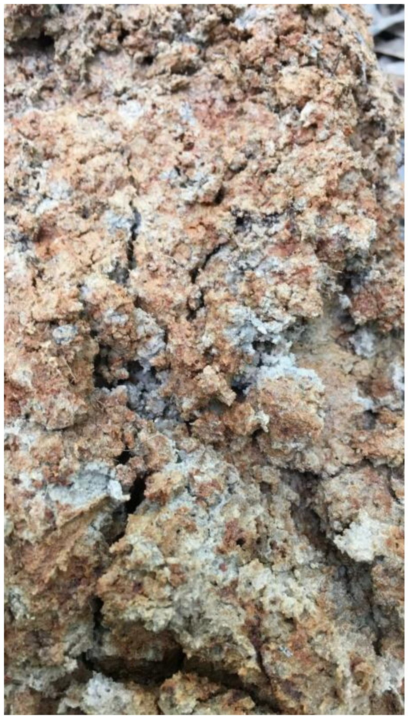 

Figure 52. Redox features observed in a soil profile from Site 3 (left).

Figure 53. High water table (A2), a primary indicator of wetland hydrology, observed in a soil pit on Site 3 (right).

Figure 54. Drift lines and water marks, primary indicators of hydrology, observed on Site 3.

Boggy Slough Conservation Area

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Boggy Slough South City/County: Trinity County Sampling Date: 05/08/2017

Applicant/Owner: TLL Temple Foundation State: TX Sampling Point: 1

Investigator(s): A. Camp & J. Grogan Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.30500000 Long: -94.90056667 Datum: WGS 84

Soil Map Unit Name: Ozias-Pophers complex, 0 to 1% percent slopes NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? Yes X No ______ | | **Is the Sampled Area within a Wetland?** Yes X No ______ |
| Hydric Soil Present? Yes X No ______ | | |
| Wetland Hydrology Present? Yes X No ______ | | |
| Remarks: | | |

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

| | |
|---|---|
| ☐ Surface Water (A1) | ☐ Aquatic Fauna (B13) |
| ☐ High Water Table (A2) | ☐ Marl Deposits (B15) **(LRR U)** |
| ☐ Saturation (A3) | ☐ Hydrogen Sulfide Odor (C1) |
| ☑ Water Marks (B1) | ☐ Oxidized Rhizospheres along Living Roots (C3) |
| ☐ Sediment Deposits (B2) | ☐ Presence of Reduced Iron (C4) |
| ☐ Drift Deposits (B3) | ☐ Recent Iron Reduction in Tilled Soils (C6) |
| ☐ Algal Mat or Crust (B4) | ☐ Thin Muck Surface (C7) |
| ☐ Iron Deposits (B5) | ☐ Other (Explain in Remarks) |
| ☐ Inundation Visible on Aerial Imagery (B7) | |
| ☑ Water-Stained Leaves (B9) | |

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

**Wetland Hydrology Present?** Yes X No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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Figure 55a. Site information and hydrology indicators for Site 4, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants. Sampling Point: 1

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Quercus lyrata | 50 | Y | OBL |
| 2. Liquidambar styraciflua | 20 | Y | FAC |
| 3. Nyssa sylvatica | 15 | N | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 85 | = Total Cover | |
| 50% of total cover: 42.5 | 20% of total cover: 17 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Ilex opaca | 25 | Y | FAC |
| 2. Triadica sebifera | 15 | Y | FAC |
| 3. Ulmus rubra | 1 | N | FAC |
| 4. Fraxinus pennsylvanica | 1 | N | FACW |
| 5. Callicarpa americana | 1 | N | FACU |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 43 | = Total Cover | |
| 50% of total cover: 21.5 | 20% of total cover: 8.6 | | |

| Herb Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Echinochloa crus-galli | 10 | Y | FACW |
| 2. Smilax sp. | 1 | N | FAC |
| 3. Vitis rotundifolia | 1 | N | FAC |
| 4. Ampelopsis arborea | 1 | N | FAC |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 13 | = Total Cover | |
| 50% of total cover: 6.5 | 20% of total cover: 2.6 | | |

| Woody Vine Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | | = Total Cover | |
| 50% of total cover: | 20% of total cover: | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 50 | x 1 = 50 |
| FACW species | 11 | x 2 = 22 |
| FAC species | 79 | x 3 = 237 |
| FACU species | 1 | x 4 = 4 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 141 (A) | 313 (B) |

Prevalence Index = B/A = 2.22

**Hydrophytic Vegetation Indicators:**

__ 1 - Rapid Test for Hydrophytic Vegetation
__ 2 - Dominance Test is >50%
__ 3 - Prevalence Index is ≤3.0[1]
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub –** Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ___

Remarks: (If observed, list morphological adaptations below).

Trees exhibited buttressing.

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Figure 55b. Vegetation cover by strata and morphological adaptations for Site 4, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1-0 | N/A | | | | | | | O horizon |
| 0-5 | 5 YR 5/1 | 50 | 2.5 YR 3/6 | 50 | C | PL | Silty clay loam | A horizon |
| 5- | 10 R 6/1 | 60 | 2.5 YR 3/6 | 40 | C | PL | Silty clay loam | E horizon |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present?** Yes X No ____

Remarks:

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Figure 55c. Soil indicators for Site 4, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region**

Project/Site: Boggy Slough South City/County: Trinity County Sampling Date: 05/08/2017

Applicant/Owner: TLL Temple Foundation State: TX Sampling Point: 5

Investigator(s): A. Camp & J. Grogan Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): Concave Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 31.32694000 Long: -94.89972000 Datum: WGS 84

Soil Map Unit Name: Ozias-Pophers complex, 0 to 1% percent slopes NWI classification: PFO1A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? Yes X No ______ | | **Is the Sampled Area within a Wetland?** **Yes** X **No** ______ |
| Hydric Soil Present? Yes X No ______ | | |
| Wetland Hydrology Present? Yes X No ______ | | |
| Remarks: | | |

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☑ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☑ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

**Wetland Hydrology Present? Yes** X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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Figure 56a. Site information and hydrology indicators for Site 4, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants.

Sampling Point: 5

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Liquidambar styraciflua | 30 | Y | FAC |
| 2. Carya aquatica | 30 | Y | OBL |
| 3. Quercus phellos | 25 | Y | FACW |
| 4. Quercus lyrata | 20 | N | OBL |
| 5. Ilex opaca | 10 | N | FAC |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 115 | = Total Cover | |
| 50% of total cover: 57.5 | 20% of total cover: 23 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 acre) | | | |
|---|---|---|---|
| 1. Liquidambar styraciflua | 5 | Y | FAC |
| 2. Quercus nigra | 1 | N | FAC |
| 3. Quercus phellos | 1 | N | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 7 | = Total Cover | |
| 50% of total cover: 3.5 | 20% of total cover: 1.4 | | |

| Herb Stratum (Plot size: 1/10 acre) | | | |
|---|---|---|---|
| 1. Echinochloa crus-galli | 2 | Y | FACW |
| 2. Eleocharis baldwinii | 2 | Y | OBL |
| 3. Sabal minor | 1 | N | FAC |
| 4. Ampelopsis arborea | 1 | N | FAC |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 6 | = Total Cover | |
| 50% of total cover: 3 | 20% of total cover: 1.2 | | |

| Woody Vine Stratum (Plot size: 1/10 acre) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | | = Total Cover | |
| 50% of total cover: | 20% of total cover: | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 32 | x 1 = 32 |
| FACW species | 28 | x 2 = 56 |
| FAC species | 48 | x 3 = 144 |
| FACU species | 0 | x 4 = 0 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 108 (A) | 232 (B) |

Prevalence Index = B/A = 2.15

**Hydrophytic Vegetation Indicators:**

__ 1 - Rapid Test for Hydrophytic Vegetation

__ 2 - Dominance Test is >50%

__ 3 - Prevalence Index is ≤3.0[1]

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree –** Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub –** Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb –** All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine –** All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No _____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 56b. Vegetation cover by strata and morphological adaptations for Site 4, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 5

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1-0 | N/A | | | | | | | O horizon |
| 0-6 | 5 YR 5/2 | 60 | 2.5 YR 3/6 | 40 | C | PL | Silty clay loam | A horizon |
| 6- | 7.5 YR 5/2 | 50 | 2.5 YR 4/8 | 50 | C | PL | Silty clay loam | E horizon |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- [ ] Histosol (A1)
- [ ] Histic Epipedon (A2)
- [ ] Black Histic (A3)
- [ ] Hydrogen Sulfide (A4)
- [ ] Stratified Layers (A5)
- [ ] Organic Bodies (A6) **(LRR P, T, U)**
- [ ] 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- [ ] Muck Presence (A8) **(LRR U)**
- [ ] 1 cm Muck (A9) **(LRR P, T)**
- [ ] Depleted Below Dark Surface (A11)
- [ ] Thick Dark Surface (A12)
- [ ] Coast Prairie Redox (A16) **(MLRA 150A)**
- [ ] Sandy Mucky Mineral (S1) **(LRR O, S)**
- [ ] Sandy Gleyed Matrix (S4)
- [ ] Sandy Redox (S5)
- [ ] Stripped Matrix (S6)
- [ ] Dark Surface (S7) **(LRR P, S, T, U)**
- [ ] Polyvalue Below Surface (S8) **(LRR S, T, U)**
- [ ] Thin Dark Surface (S9) **(LRR S, T, U)**
- [ ] Loamy Mucky Mineral (F1) **(LRR O)**
- [ ] Loamy Gleyed Matrix (F2)
- [x] Depleted Matrix (F3)
- [ ] Redox Dark Surface (F6)
- [ ] Depleted Dark Surface (F7)
- [ ] Redox Depressions (F8)
- [ ] Marl (F10) **(LRR U)**
- [ ] Depleted Ochric (F11) **(MLRA 151)**
- [ ] Iron-Manganese Masses (F12) **(LRR O, P, T)**
- [ ] Umbric Surface (F13) **(LRR P, T, U)**
- [ ] Delta Ochric (F17) **(MLRA 151)**
- [ ] Reduced Vertic (F18) **(MLRA 150A, 150B)**
- [ ] Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- [ ] 1 cm Muck (A9) **(LRR O)**
- [ ] 2 cm Muck (A10) **(LRR S)**
- [ ] Reduced Vertic (F18) **(outside MLRA 150A,B)**
- [ ] Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- [ ] Red Parent Material (TF2)
- [ ] Very Shallow Dark Surface (TF12)
- [ ] Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ________

Depth (inches): ________

**Hydric Soil Present?** **Yes** X **No** ____

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 56c. Soil indicators for Site 4, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

Figure 57.  Drift deposits, a primary indicator of wetland hydrology, observed on Site 4.

Figure 58. Redox features observed in a soil pit dug at Site 4.

Sacul, TX

## WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Private tract in Sacul, TX City/County: Nacogdoches County Sampling Date: 10/30/2017

Applicant/Owner: Private owner State: TX Sampling Point: 1

Investigator(s): A. Camp & J. Grogan Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): none Slope (%): 2%

Subregion (LRR or MLRA): LRR-P Lat: 31.79246333 Long: -94.97476555 Datum: WGS 84

Soil Map Unit Name: Mantachie soil, frequently flooded NWI classification: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes X No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

**SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.**

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ______ | **Is the Sampled Area within a Wetland?** **Yes** X **No** ______ |
| Hydric Soil Present? | Yes X No ______ | |
| Wetland Hydrology Present? | Yes X No ______ | |

Remarks:

### HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [ ] Saturation (A3)
- [x] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [ ] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] Marl Deposits (B15) **(LRR U)**
- [ ] Hydrogen Sulfide Odor (C1)
- [x] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [ ] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [ ] Crayfish Burrows (C8)
- [x] Saturation Visible on Aerial Imagery (C9)
- [ ] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] FAC-Neutral Test (D5)
- [ ] Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

**Wetland Hydrology Present? Yes** X **No** ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 59a. Site information and hydrology indicators for Site 5, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata)** – Use scientific names of plants.

Sampling Point: 1

| Tree Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 0 = Total Cover | | |
| 50% of total cover: 0 | 20% of total cover: 0 | | |

| Sapling/Shrub Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | = Total Cover | | |
| 50% of total cover: | 20% of total cover: | | |

| Herb Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Carex sp. | 15 | Y | FAC |
| 2. Quercus lyrata | 5 | Y | OBL |
| 3. Arundinaria gigantea | 5 | Y | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 25 = Total Cover | | |
| 50% of total cover: 12.5 | 20% of total cover: 5 | | |

| Woody Vine Stratum (Plot size: 1/10 acre) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Rubus trivialis | 5 | Y | FACU |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 5 = Total Cover | | |
| 50% of total cover: 2.5 | 20% of total cover: 1 | | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | 5 | x 1 = 5 |
| FACW species | 5 | x 2 = 10 |
| FAC species | 15 | x 3 = 45 |
| FACU species | 5 | x 4 = 20 |
| UPL species | 0 | x 5 = 0 |
| Column Totals: | 30 (A) | 80 (B) |

Prevalence Index = B/A = 2.67

**Hydrophytic Vegetation Indicators:**

- ☑ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub** – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 59b. Vegetation cover by strata and morphological adaptations for Site 5, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL**

Sampling Point: 1

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0.5-1 | N/A | | | | | | | O horizon |
| 1-8 | 5 YR 3/2 | 98 | 10 R 2.5/1 | 2 | C | M | sandy clay loam | A horizon, Fe/Mn masses |
| 8- | 5 YR 4/6 | 85 | 5 YR 5/1 | 15 | D | M | sandy clay loam | E horizon |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- [ ] Histosol (A1)
- [ ] Histic Epipedon (A2)
- [ ] Black Histic (A3)
- [ ] Hydrogen Sulfide (A4)
- [ ] Stratified Layers (A5)
- [ ] Organic Bodies (A6) **(LRR P, T, U)**
- [ ] 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- [ ] Muck Presence (A8) **(LRR U)**
- [ ] 1 cm Muck (A9) **(LRR P, T)**
- [ ] Depleted Below Dark Surface (A11)
- [ ] Thick Dark Surface (A12)
- [ ] Coast Prairie Redox (A16) **(MLRA 150A)**
- [ ] Sandy Mucky Mineral (S1) **(LRR O, S)**
- [ ] Sandy Gleyed Matrix (S4)
- [ ] Sandy Redox (S5)
- [ ] Stripped Matrix (S6)
- [ ] Dark Surface (S7) **(LRR P, S, T, U)**
- [ ] Polyvalue Below Surface (S8) **(LRR S, T, U)**
- [ ] Thin Dark Surface (S9) **(LRR S, T, U)**
- [ ] Loamy Mucky Mineral (F1) **(LRR O)**
- [ ] Loamy Gleyed Matrix (F2)
- [ ] Depleted Matrix (F3)
- [ ] Redox Dark Surface (F6)
- [ ] Depleted Dark Surface (F7)
- [ ] Redox Depressions (F8)
- [ ] Marl (F10) **(LRR U)**
- [ ] Depleted Ochric (F11) **(MLRA 151)**
- [x] Iron-Manganese Masses (F12) **(LRR O, P, T)**
- [ ] Umbric Surface (F13) **(LRR P, T, U)**
- [ ] Delta Ochric (F17) **(MLRA 151)**
- [ ] Reduced Vertic (F18) **(MLRA 150A, 150B)**
- [ ] Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- [ ] 1 cm Muck (A9) **(LRR O)**
- [ ] 2 cm Muck (A10) **(LRR S)**
- [ ] Reduced Vertic (F18) **(outside MLRA 150A,B)**
- [ ] Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- [ ] Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- [ ] Red Parent Material (TF2)
- [ ] Very Shallow Dark Surface (TF12)
- [ ] Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present?** **Yes** X **No** ______

Remarks:

US Army Corps of Engineers — Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 59c. Soil indicators for Site 5, plot 1, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

## WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Private tract in Sacul, TX City/County: Nacogdoches County Sampling Date: 10/30/2017

Applicant/Owner: Private owner State: TX Sampling Point: 5

Investigator(s): A. Camp & J. Grogan Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Floodplain Local relief (concave, convex, none): none Slope (%): 2%

Subregion (LRR or MLRA): LRR-P Lat: 31.79388889 Long: -94.97333333 Datum: WGS 84

Soil Map Unit Name: Mantachie soil, frequently flooded NWI classification: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

### SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes X No ___ | Is the Sampled Area within a Wetland? Yes X No ___ |
| Hydric Soil Present? | Yes X No ___ | |
| Wetland Hydrology Present? | Yes X No ___ | |

Remarks:

### HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☑ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☑ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

**Field Observations:**

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ______

**Wetland Hydrology Present? Yes X No ___**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Water marks were evident on the few trees that remained on the site. Aerial photos displayed saturation and hardwood tree cover on the site.

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 60a. Site information and hydrology indicators for Site 5, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**VEGETATION (Four Strata) –** Use scientific names of plants. Sampling Point: 5

**Tree Stratum** (Plot size: 1/10 acre)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 0 = Total Cover | | |

50% of total cover: 0 20% of total cover: 0

**Sapling/Shrub Stratum** (Plot size: 1/10 acre)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| | 0 = Total Cover | | |

50% of total cover: 0 20% of total cover: 0

**Herb Stratum** (Plot size: 1/10 acre)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Carex sp. | 5 | Y | FAC |
| 2. Carpinus caroliniana | 2 | Y | FAC |
| 3. Quercus lyrata | 1 | N | OBL |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 8 = Total Cover | | |

50% of total cover: 4 20% of total cover: 1.6

**Woody Vine Stratum** (Plot size: 1/10 acre)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 0 = Total Cover | | |

50% of total cover: 0 20% of total cover: 0

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 1 | x 1 = | 1 |
| FACW species | 0 | x 2 = | 0 |
| FAC species | 7 | x 3 = | 21 |
| FACU species | 0 | x 4 = | 0 |
| UPL species | 0 | x 5 = | 0 |
| Column Totals: | 8 (A) | | 22 (B) |

Prevalence Index = B/A = 2.75

**Hydrophytic Vegetation Indicators:**

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☑ 2 - Dominance Test is >50%
- ☑ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Four Vegetation Strata:**

**Tree** – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/Shrub** – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vine** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** **Yes** X **No** ____

Remarks: (If observed, list morphological adaptations below).

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 60b. Vegetation cover by strata and morphological adaptations for Site 5, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).

**SOIL** Sampling Point: 5

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0.25-0 | | | | | | | | O horizon |
| 0-3.5 | 5 YR 4/1 | 60 | 5 YR 4/6 | 40 | C | PL | Clay loam | A horizon |
| 3.5- | 5 YR 4/6 | 90 | 5 YR 5/1 | 10 | D | M | Clay loam | E horizon |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

**Indicators for Problematic Hydric Soils[3]:**

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: ______

Depth (inches): ______

**Hydric Soil Present?** **Yes** X **No** ______

Remarks:

US Army Corps of Engineers Atlantic and Gulf Coastal Plain Region – Version 2.0

Figure 60c. Soil indicators for Site 5, plot 5, following procedures for the AGCP Regional Supplement (U.S. Army Corps of Engineers 2010).


Figure 61.  Representative photo of disturbed Site 5.

Figure 62.  Redox features found in a soil ped on Site 5.

Table 43. Individual SEHGM Variable Subindex (VSI) scores for plots 1-5 of Site 1, Lake Naconiche Mitigation Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{CATCH}$ | NA | NA | NA | NA | NA | NA |
| $V_{UPUSE}$ | NA | NA | NA | NA | NA | NA |
| $V_{CONNECT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOILINT}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{HYDROSYS}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{HYDROALT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BIG3}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{CTDEN}$ | 0.38 | 1.00 | 1.00 | 1.00 | 1.00 | 0.88 |
| $V_{SSC}$ | NA | NA | NA | NA | NA | NA |
| $V_{GVC}$ | NA | NA | NA | NA | NA | NA |
| $V_{WD}$ | 1.00 | 0.96 | 0.51 | 0.22 | 0.00 | 0.54 |
| $V_{COMP}$ | 0.97 | 0.50 | 0.50 | 0.82 | 0.96 | 0.75 |

Table 44. Individual SEHGM Variable Subindex (VSI) scores for plots 1-5 of Site 2, Stephen F. Austin Experimental Forest.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{CATCH}$ | NA | NA | NA | NA | NA | NA |
| $V_{UPUSE}$ | NA | NA | NA | NA | NA | NA |
| $V_{CONNECT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOILINT}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{HYDROSYS}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{HYDROALT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BIG3}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{CTDEN}$ | 0.88 | 1.00 | 0.88 | 1.00 | 0.88 | 0.93 |
| $V_{SSC}$ | NA | NA | NA | NA | NA | NA |
| $V_{GVC}$ | NA | NA | NA | NA | NA | NA |
| $V_{WD}$ | 1.00 | 0.49 | 0.60 | 0.99 | 1.00 | 0.82 |
| $V_{COMP}$ | 0.71 | 0.71 | 0.87 | 0.71 | 0.71 | 0.74 |

Table 45. Individual SEHGM Variable Subindex (VSI) scores for plots 1-5 of Site 3, Alazan Wildlife Management Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{CATCH}$ | NA | NA | NA | NA | NA | NA |
| $V_{UPUSE}$ | NA | NA | NA | NA | NA | NA |
| $V_{CONNECT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOILINT}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{HYDROSYS}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{HYDROALT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BIG3}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{CTDEN}$ | 1.00 | 1.00 | 0.88 | 0.88 | 1.00 | |
| $V_{SSC}$ | NA | NA | NA | NA | NA | NA |
| $V_{GVC}$ | NA | NA | NA | NA | NA | NA |
| $V_{WD}$ | 0.50 | 0.33 | 0.48 | 0.28 | 0.00 | 0.32 |
| $V_{COMP}$ | 0.71 | 0.71 | 0.87 | 0.50 | 0.71 | 0.70 |

Table 46. Individual SEHGM Variable Subindex (VSI) scores for plots 1-5 of Site 4, Boggy Slough Conservation Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{CATCH}$ | NA | NA | NA | NA | NA | NA |
| $V_{UPUSE}$ | NA | NA | NA | NA | NA | NA |
| $V_{CONNECT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOILINT}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{HYDROSYS}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{HYDROALT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BIG3}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{CTDEN}$ | 0.63 | 1.00 | 1.00 | 0.63 | 0.75 | 0.80 |
| $V_{SSC}$ | NA | NA | NA | NA | NA | NA |
| $V_{GVC}$ | NA | NA | NA | NA | NA | NA |
| $V_{WD}$ | 0.83 | 0.45 | 0.38 | 0.12 | 0.00 | 0.36 |
| $V_{COMP}$ | 0.71 | 0.71 | 0.87 | 0.71 | 0.87 | 0.77 |

Table 47. Individual SEHGM Variable Subindex (VSI) scores for plots 1-5 of Site 5, Sacul, TX.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{CATCH}$ | NA | NA | NA | NA | NA | NA |
| $V_{UPUSE}$ | NA | NA | NA | NA | NA | NA |
| $V_{CONNECT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOILINT}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{HYDROSYS}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{HYDROALT}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BIG3}$ | NA | NA | NA | NA | NA | NA |
| $V_{CTDEN}$ | NA | NA | NA | NA | NA | NA |
| $V_{SSC}$ | NA | NA | NA | NA | NA | NA |
| $V_{GVC}$ | 0.05 | 0.00 | 0.00 | 0.03 | 0.00 | 0.02 |
| $V_{WD}$ | 1.00 | 0.67 | 0.34 | 0.35 | 0.17 | 0.51 |
| $V_{COMP}$ | 0.29 | 0.29 | 0.50 | 0.58 | 0.29 | 0.39 |

Table 48. Individual ETXHGM Variable Subindex (VSI) scores for plots 1-5 of Site 1, Lake Naconiche Mitigation Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{PATCH}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BUF30}$ | NA | NA | NA | NA | NA | NA |
| $V_{BUF250}$ | NA | NA | NA | NA | NA | NA |
| $V_{FREQ}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{DUR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{POND}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{STRATA}$ | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| $V_{SOIL}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{TBA}$ | 0.64 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TDEN}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SNAG}$ | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{OHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{AHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TCOMP}$ | 0.73 | 0.66 | 0.66 | 0.66 | 0.58 | 0.66 |
| $V_{SSD}$ | 0.42 | 0.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| $V_{GVC}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LITTER}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LOG}$ | 1.00 | 0.58 | 1.00 | 0.54 | 0.00 | 1.00 |
| $V_{WD}$ | 1.00 | 0.50 | 1.00 | 1.00 | 1.00 | 1.00 |

Table 49. Individual ETXHGM Variable Subindex (VSI) scores for plots 1-5 of Site 2, Stephen F. Austin Experimental Forest.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{PATCH}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BUF30}$ | NA | NA | NA | NA | NA | |
| $V_{BUF250}$ | NA | NA | NA | NA | NA | |
| $V_{FREQ}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{DUR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{POND}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{STRATA}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SOIL}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{TBA}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TDEN}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SNAG}$ | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{OHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{AHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TCOMP}$ | 0.83 | 0.83 | 0.66 | 0.66 | 0.83 | 0.76 |
| $V_{SSD}$ | 0.21 | 0.52 | 1.00 | 0.10 | 0.93 | 0.73 |
| $V_{GVC}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LITTER}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LOG}$ | 1.00 | 1.00 | 1.00 | 0.69 | 0.82 | 1.00 |
| $V_{WD}$ | 1.00 | 0.91 | 1.00 | 0.51 | 0.50 | 0.75 |

Table 50. Individual ETXHGM Variable Subindex (VSI) scores for plots 1-5 of Site 3, Alazan Wildlife Management Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{PATCH}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BUF30}$ | NA | NA | NA | NA | NA | NA |
| $V_{BUF250}$ | NA | NA | NA | NA | NA | NA |
| $V_{FREQ}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{DUR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{POND}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{STRATA}$ | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| $V_{SOIL}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{TBA}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TDEN}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SNAG}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{OHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{AHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TCOMP}$ | 1.00 | 0.89 | 0.89 | 0.66 | 0.77 | 0.83 |
| $V_{SSD}$ | 0.58 | 0.50 | 0.50 | 0.31 | 0.83 | 0.58 |
| $V_{GVC}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LITTER}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LOG}$ | 0.83 | 1.00 | 1.00 | 0.71 | 0.00 | 0.95 |
| $V_{WD}$ | 1.00 | 0.96 | 0.96 | 0.50 | 0.58 | 0.52 |

Table 51. Individual ETXHGM Variable Subindex (VSI) scores for plots 1-5 of Site 4, Boggy Slough Conservation Area.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{PATCH}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BUF30}$ | NA | NA | NA | NA | NA | |
| $V_{BUF250}$ | NA | NA | NA | NA | NA | |
| $V_{FREQ}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{DUR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{POND}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{STRATA}$ | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| $V_{SOIL}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{TBA}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TDEN}$ | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{SNAG}$ | 1.00 | 1.00 | 0.60 | 1.00 | 0.00 | 1.00 |
| $V_{OHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{AHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{TCOMP}$ | 0.66 | 1.00 | 1.00 | 0.83 | 0.89 | 0.88 |
| $V_{SSD}$ | 0.62 | 0.31 | 1.00 | 0.73 | 0.52 | 0.44 |
| $V_{GVC}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LITTER}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LOG}$ | 0.50 | 1.00 | 0.94 | 0.30 | 0.00 | 1.00 |
| $V_{WD}$ | 0.50 | 0.54 | 1.00 | 0.73 | 1.00 | 0.79 |

Table 52. Individual ETXHGM Variable Subindex (VSI) scores for plots 1-5 of Site 5, Sacul, TX.

| Variable | Plot Variable Subindices | | | | | Average Variable Subindex Score (VSI) |
|---|---|---|---|---|---|---|
| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | |
| $V_{PATCH}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{BUF30}$ | NA | NA | NA | NA | NA | NA |
| $V_{BUF250}$ | NA | NA | NA | NA | NA | NA |
| $V_{FREQ}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{DUR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{POND}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{STRATA}$ | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| $V_{SOIL}$ | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| $V_{TBA}$ | 0.00 | 0.00 | 0.13 | 0.13 | 0.00 | 0.05 |
| $V_{TDEN}$ | 0.00 | 0.00 | 0.13 | 0.00 | 0.00 | 0.03 |
| $V_{SNAG}$ | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.50 |
| $V_{OHOR}$ | 0.52 | 0.52 | 0.20 | 1.00 | 0.20 | 0.49 |
| $V_{AHOR}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{COMP}$ | 0.50 | 0.55 | 1.00 | 0.78 | 0.55 | 0.68 |
| $V_{SSD}$ | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.04 |
| $V_{GVC}$ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $V_{LITTER}$ | 1.00 | 0.50 | 0.66 | 0.50 | 0.63 | 0.65 |
| $V_{LOG}$ | 1.00 | 0.50 | 0.83 | 0.87 | 0.41 | 1.00 |
| $V_{WD}$ | 0.50 | 0.50 | 1.00 | 1.00 | 0.97 | 0.61 |

Table 53. Individual TXRAM metric scores and total core element scores (in bold) for plots 1-5 of Site 1, Lake Naconiche Mitigation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| **Landscape** | **13.88** | **13.88** | **13.88** | **13.88** | **13.88** | **13.88** |
| Aquatic Context | 4 | 4 | 4 | 4 | 4 | 4 |
| Buffer | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 |
| **Hydrology** | **30** | **30** | **30** | **30** | **30** | **30** |
| Water Source | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydroperiod | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydrologic Flow | 4 | 4 | 4 | 4 | 4 | 4 |
| **Soils** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** |
| Organic Matter | 2 | 2 | 2 | 2 | 2 | 2 |
| Sedimentation | 4 | 4 | 4 | 4 | 4 | 4 |
| Soil Modification | 3 | 3 | 3 | 3 | 3 | 3 |
| **Physical Structure** | **18.33** | **18.33** | **18.33** | **18.33** | **18.33** | **18.33** |
| Topographic Complexity | 3 | 3 | 3 | 3 | 3 | 3 |
| Edge Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Physical Habitat Richness | 4 | 4 | 4 | 4 | 4 | 4 |
| **Biotic Structure** | **18.57** | **17.86** | **17.86** | **17.86** | **17.86** | **18.00** |
| Plant Strata | 4 | 4 | 4 | 4 | 4 | 4 |
| Species Richness | 2 | 1 | 1 | 1 | 1 | 1.2 |
| Non-Native/Invasive Infestation | 4 | 4 | 4 | 1 | 4 | 3.4 |
| Interspersion | 4 | 4 | 4 | 4 | 4 | 4 |
| Strata Overlap | 4 | 4 | 4 | 4 | 4 | 4 |
| Herbaceous Cover | 4 | 4 | 4 | 4 | 4 | 4 |
| Vegetation Alterations | 4 | 4 | 4 | 4 | 4 | 4 |
| **Total** | **92.03** | **91.32** | **91.32** | **91.32** | **91.32** | **91.46** |

Table 54. Individual TXRAM metric scores for plots 1-5 of Site 2, Stephen F. Austin Experimental Forest.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| **Landscape** | **13.13** | **13.13** | **13.13** | **13.13** | **13.13** | **13.13** |
| Aquatic Context | 3 | 3 | 3 | 3 | 3 | 3 |
| Buffer | 4 | 4 | 4 | 4 | 4 | 4 |
| **Hydrology** | **30** | **30** | **30** | **30** | **30** | **30** |
| Water Source | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydroperiod | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydrologic Flow | 4 | 4 | 4 | 4 | 4 | 4 |
| **Soils** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** |
| Organic Matter | 2 | 2 | 2 | 2 | 2 | 2 |
| Sedimentation | 4 | 4 | 4 | 4 | 4 | 4 |
| Soil Modification | 3 | 3 | 3 | 3 | 3 | 3 |
| **Physical Structure** | **18.33** | **18.33** | **18.33** | **18.33** | **18.33** | **18.33** |
| Topographic Complexity | 3 | 3 | 3 | 3 | 3 | 3 |
| Edge Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Physical Habitat Richness | 4 | 4 | 4 | 4 | 4 | 4 |
| **Biotic Structure** | **15.71** | **16.43** | **17.14** | **16.43** | **17.14** | **16.57** |
| Plant Strata | 4 | 4 | 4 | 4 | 4 | 4 |
| Species Richness | 1 | 1 | 2 | 1 | 1 | 1.2 |
| Non-Native/Invasive Infestation | 1 | 2 | 2 | 2 | 3 | 2 |
| Interspersion | 4 | 4 | 4 | 4 | 4 | 4 |
| Strata Overlap | 4 | 4 | 4 | 4 | 4 | 4 |
| Herbaceous Cover | 4 | 4 | 4 | 4 | 4 | 4 |
| Vegetation Alterations | 4 | 4 | 4 | 4 | 4 | 4 |
| **Total** | **88.42** | **89.14** | **89.85** | **89.14** | **89.85** | **89.28** |

Table 55. Individual TXRAM metric scores for plots 1-5 of Site 3, Alazan Wildlife Management Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| **Landscape** | **15** | **15** | **15** | **15** | **15** | **15** |
| Aquatic Context | 4 | 4 | 4 | 4 | 4 | 4 |
| Buffer | 4 | 4 | 4 | 4 | 4 | 4 |
| **Hydrology** | **30** | **30** | **30** | **30** | **30** | **30** |
| Water Source | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydroperiod | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydrologic Flow | 4 | 4 | 4 | 4 | 4 | 4 |
| **Soils** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** |
| Organic Matter | 2 | 2 | 2 | 2 | 2 | 2 |
| Sedimentation | 4 | 4 | 4 | 4 | 4 | 4 |
| Soil Modification | 3 | 3 | 3 | 3 | 3 | 3 |
| **Physical Structure** | **20** | **20** | **20** | **20** | **20** | **20** |
| Topographic Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Edge Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Physical Habitat Richness | 4 | 4 | 4 | 4 | 4 | 4 |
| **Biotic Structure** | **17.14** | **17.86** | **17.14** | **17.14** | **18.57** | **17.57** |
| Plant Strata | 4 | 4 | 4 | 4 | 4 | 4 |
| Species Richness | 2 | 1 | 1 | 1 | 3 | 1.6 |
| Non-Native/Invasive Infestation | 2 | 4 | 3 | 3 | 3 | 3 |
| Interspersion | 4 | 4 | 4 | 4 | 4 | 4 |
| Strata Overlap | 4 | 4 | 4 | 4 | 4 | 4 |
| Herbaceous Cover | 4 | 4 | 4 | 4 | 4 | 4 |
| Vegetation Alterations | 4 | 4 | 4 | 4 | 4 | 4 |
| **Total** | **93.39** | **94.11** | **93.39** | **93.39** | **94.82** | **93.82** |

Table 56. Individual TXRAM metric scores for plots 1-5 of Site 4, Boggy Slough Conservation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| **Landscape** | **13.13** | **13.13** | **13.13** | **13.13** | **13.13** | **13.13** |
| Aquatic Context | 3 | 3 | 3 | 3 | 3 | 3 |
| Buffer | 4 | 4 | 4 | 4 | 4 | 4 |
| **Hydrology** | **30** | **30** | **30** | **30** | **30** | **30** |
| Water Source | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydroperiod | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydrologic Flow | 4 | 4 | 4 | 4 | 4 | 4 |
| **Soils** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** | **11.25** |
| Organic Matter | 2 | 2 | 2 | 2 | 2 | 2 |
| Sedimentation | 4 | 4 | 4 | 4 | 4 | 4 |
| Soil Modification | 3 | 3 | 3 | 3 | 3 | 3 |
| **Physical Structure** | **16.67** | **16.67** | **16.67** | **16.67** | **16.67** | **16.67** |
| Topographic Complexity | 2 | 2 | 2 | 2 | 2 | 2 |
| Edge Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Physical Habitat Richness | 4 | 4 | 4 | 4 | 4 | 4 |
| **Biotic Structure** | **17.14** | **18.57** | **18.57** | **17.86** | **19.29** | **18.29** |
| Plant Strata | 4 | 4 | 4 | 4 | 4 | 4 |
| Species Richness | 1 | 3 | 2 | 3 | 3 | 2.4 |
| Non-Native/Invasive Infestation | 3 | 3 | 4 | 2 | 4 | 3.2 |
| Interspersion | 4 | 4 | 4 | 4 | 4 | 4 |
| Strata Overlap | 4 | 4 | 4 | 4 | 4 | 4 |
| Herbaceous Cover | 4 | 4 | 4 | 4 | 4 | 4 |
| Vegetation Alterations | 4 | 4 | 4 | 4 | 4 | 4 |
| **Total** | **88.18** | **89.61** | **89.61** | **88.90** | **90.33** | **89.33** |

Table 57. Individual TXRAM metric scores for plots 1-5 of Site 5, Sacul, TX.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| **Landscape** | **12.38** | **12.38** | **12.38** | **12.38** | **12.38** | **12.38** |
| Aquatic Context | 3 | 3 | 3 | 3 | 3 | 3 |
| Buffer | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 |
| **Hydrology** | **30** | **30** | **30** | **30** | **30** | **30** |
| Water Source | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydroperiod | 4 | 4 | 4 | 4 | 4 | 4 |
| Hydrologic Flow | 4 | 4 | 4 | 4 | 4 | 4 |
| **Soils** | **10** | **10** | **10** | **10** | **10** | **10** |
| Organic Matter | 2 | 2 | 2 | 2 | 2 | 2 |
| Sedimentation | 4 | 4 | 4 | 4 | 4 | 4 |
| Soil Modification | 2 | 2 | 2 | 2 | 2 | 2 |
| **Physical Structure** | **15** | **15** | **15** | **15** | **15** | **15** |
| Topographic Complexity | 3 | 3 | 3 | 3 | 3 | 3 |
| Edge Complexity | 4 | 4 | 4 | 4 | 4 | 4 |
| Physical Habitat Richness | 2 | 2 | 2 | 2 | 2 | 2 |
| **Biotic Structure** | **7.14** | **7.14** | **7.14** | **7.14** | **7.14** | **7.14** |
| Plant Strata | 1 | 1 | 1 | 1 | 1 | 1 |
| Species Richness | 1 | 1 | 1 | 1 | 1 | 1 |
| Non-Native/Invasive Infestation | 4 | 4 | 4 | 4 | 4 | 4 |
| Interspersion | 2 | 2 | 2 | 2 | 2 | 2 |
| Strata Overlap | 1 | 1 | 1 | 1 | 1 | 1 |
| Herbaceous Cover | 1 | 1 | 1 | 1 | 1 | 1 |
| Vegetation Alterations | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **74.52** | **74.52** | **74.52** | **74.52** | **74.52** | **74.52** |

Table 58. Individual WHAP component scores for plots 1-5 of Site 1, Lake Naconiche Mitigation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | | | | | | |
| Criterion A | 4 | 1 | 3 | 4 | 3 | 3 |
| Criterion B | 3 | 1 | 3 | 3 | 1 | 2.2 |
| Component 5 | 5 | 4 | 5 | 5 | 4 | 4.6 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | | | | | | |
| Criterion A | 5 | 3 | 5 | 5 | 5 | 4.6 |
| Criterion B | 3 | 1 | 1 | 3 | 3 | 2.2 |
| Total | 72 | 62 | 69 | 72 | 68 | 68.6 |

Table 59. Individual WHAP component scores for plots 1-5 of Site 2, Stephen F. Austin Experimental Forest.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | | | | | | |
| Criterion A | 4 | 3 | 3 | 2 | 4 | 3.2 |
| Criterion B | 3 | 1 | 3 | 1 | 3 | 2.2 |
| Component 5 | 4 | 5 | 5 | 5 | 5 | 4.8 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | | | | | | |
| Criterion A | 5 | 3 | 5 | 5 | 5 | 4.6 |
| Criterion B | 1 | 3 | 1 | 1 | 1 | 1.4 |
| Total | 69 | 67 | 69 | 66 | 70 | 68.2 |

Table 60. Individual WHAP component scores for plots 1-5 of Site 3, Alazan Wildlife Management Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 6 | 12 | 12 | 12 | 12 | 10.8 |
| Component 3 | 20 | 20 | 20 | 20 | 20 | 20 |
| Component 4 | | | | | | |
| Criterion A | 3 | 4 | 4 | 2 | 2 | 3 |
| Criterion B | 3 | 1 | 3 | 1 | 3 | 2.2 |
| Component 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | | | | | | |
| Criterion A | 3 | 5 | 5 | 5 | 5 | 4.6 |
| Criterion B | 1 | 3 | 3 | 3 | 1 | 2.2 |
| Total | 71 | 80 | 82 | 78 | 78 | 77.8 |

Table 61. Individual WHAP component scores for plots 1-5 of Site 4, Boggy Slough Conservation Area.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 12 | 12 | 12 | 12 | 12 | 12 |
| Component 3 | 10 | 10 | 10 | 10 | 10 | 10 |
| Component 4 | | | | | | |
| Criterion A | 4 | 3 | 4 | 3 | 4 | 3.6 |
| Criterion B | 3 | 3 | 3 | 3 | 3 | 3 |
| Component 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | | | | | | |
| Criterion A | 5 | 5 | 3 | 5 | 5 | 4.6 |
| Criterion B | 5 | 3 | 3 | 5 | 5 | 4.2 |
| Total | 80 | 76 | 75 | 78 | 80 | 77.9 |

Table 62. Individual WHAP component scores for plots 1-5 of Site 5, Sacul, TX.

| | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Site Average |
|---|---|---|---|---|---|---|
| Component 1 | 25 | 25 | 25 | 25 | 25 | 25 |
| Component 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Component 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 4 | | | | | | |
| Criterion A | 3 | 2 | 1 | 2 | 3 | 2.2 |
| Criterion B | 1 | 1 | 1 | 1 | 1 | 1 |
| Component 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| Component 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Component 7 | | | | | | |
| Criterion A | 0 | 0 | 0 | 0 | 0 | 0 |
| Criterion B | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 45 | 44 | 43 | 44 | 45 | 44.0 |

Species Common Names

*Acer rubrum*……………………………………….……………………..Red maple
*Ampelopsis arborea*………………………………………………………Peppervine
*Arundinaria gigantea.*…………………………………………………….Giant cane
*Brunnichia ovata*……………………………………………………Buckwheat vine
*Carpinus caroliniana*…………………………………………...American hornbeam
*Carya aquatica*……………………………..……………………..Water hickory
*Echinochloa crus-galli*…………………………………………….…Barnyard grass
*Eleocharis baldwinii*…………………………………………….Baldwin’s spikerush
*Ilex opaca*…………………………………………………...…….American holly
*Ilex vomitoria*……………………………………………………………Yaupon holly
*Liquidambar styraciflua*……………………………………………...Sweetgum
*Nyssa sylvatica*…………………………………………………………..Black tupelo
*Pinus taeda*…………………………………………...…………..Loblolly pine
*Prunus serotina*…………………………………………………….Mexican plum
*Quercus lyrata*……………………………………………………………..Overcup oak
*Quercus nigra*………………………………….…………………...Water oak
*Quercus phellos*………………………...………………………………Willow oak
*Rubus trivialis*…………………………………………………….Southern dewberry
*Saururus cernuus*…………………………………………………………...Lizard’s tail
*Triadica sebifera*…………………………………….……………..Chinese tallow
*Ulmus americana*……………………………………………………...American elm

VITA

Amy Camp (née Butler) graduated from Pine Tree High School (Longview, TX) in 2011 before attending Stephen F. Austin State University in the fall of 2011. As an undergraduate student Amy worked for the SFA Alumni Association and the Environmental Health, Safety, and Risk Department. She received her Bachelor's of Science degree in Environmental Science from Stephen F. Austin in the spring of 2015. She began graduate school at Stephen F. Austin in the fall of 2015. Amy worked as a graduate teaching assistant to the wetland delineation and functional assessment course for two and a half years, as well as many other projects throughout her graduate career. She graduated with her Master's of Science in Environmental Science in the spring of 2018.

Permanent Address: 19681 FM 15

Troup, TX 75789

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This thesis was typed by Amy M. Camp